DISCOURSE AND SOCIOTECHNICAL TRANSFORMATION

THE EMERGENCE OF REFINERY INFORMATION SYSTEMS

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ABSTRACT

This thesis considers the emergence and diffusion of British Petroleum's (BP) Refinery Information Systems (RIS). Insights from the associology of translation are coupled with the Foucauldian concepts of discourse and power/knowledge in order to analyse accounts of the system provided by organisational participants. The analysis suggests that a new form of managerialism, or "new commercial agenda" is being selectively deployed both within BP and within the wider commercial world. This transformed managerialism seeks to maintain control and heighten commercialism through a re-working of hierarchical relations within the organisation. Artefacts and practices of organisational life are revealed as prime vehicles for instantiating this new agenda and BP's Refinery Information Systems are thus seen to be both a condition and a consequence of the changes underway.

"Who makes up real things, dad?"
"Nobody and everybody; they just make themselves up. The thing is that because the real stories just happen, they don't always tell you very much. Sometimes they do, but usually they're too... messy."

The Crow Road, Iain Banks.

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DECLARATION

I declare that this thesis has been composed by me and all work reported in it is my own.

Simon Lilley Edinburgh 1993

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CHAPTER ONE

INTRODUCTION

The empirical material presented in this thesis is made up of accounts provided by organisational participants of how the task of oil refining within British Petroleum has changed and how new technological artefacts have been created to support the activities involved. In particular, the thesis seeks to examine the emergence of a Refinery Information System (RIS) at BP Oil's Grangemouth Refinery in Scotland.

The thesis is organised into ten chapters. Following this introductory piece, Chapter two examines recent work on "technology" by writers such as Bruno Latour, Michel Callon and John Law. The chapter seeks to assess the applicability of the insights offered by these writers to the task at hand. The advantages of their conceptions of sociotechnical transformation are weighed against the dangers inherent in the approach and the chapter concludes by accepting the basic orientations of this literature, with some important caveats.

Chapter three uses the Foucauldian concept of discourse to apprehend the emergence of a "new commercial agenda" (Munro and Hatherly, forthcoming) that seeks to re-engineer organisational reality. Understandings mobilized by this literature are being progressively embodied in organisational participants, practices and artefacts. Computerised information systems and "technology" in general may be seen to be both a condition and consequence of this emergent agenda and a key aim of this thesis is to examine its relations with RIS.

Having sensitised the reader to the concerns of the research and the approach adopted to meet them, we start to present empirical material on BP's RIS systems in Chapter four. The chapter focuses on the emergence of the concept of RIS within BP and its first two physical instantiations. Chapter five examines early intentions to develop a RIS type system at Grangemouth while Chapter six considers the resulting "Grangemouth RIS Project Feasibility Study".

In Chapter seven we note important changes to the physical starting point for RIS at Grangemouth that were suggested and accepted after the completion of the Feasibility Study. Chapter eight examines how these changes were instantiated at Grangemouth as we consider the processes involved in engineering the system. Chapter nine considers users' responses to the system so-built.

Chapter ten draws together the empirical material and the theoretical grounding that preceded it. Some judgements are offered on the processes involved in the construction of RIS and their links with the emergent new commercial agenda. In particular, this allows us to demonstrate RIS's role in the realisation of that agenda.

NOTES AND REFERENCES

Munro, R. and Hatherly, D. (forthcoming) "Accountability and the New Commercial Agenda", Critical Perspectives on Accounting.

CHAPTER TWO

SURVEYING TOOLS FOR SURVEILLANCE OF THE SYSTEM

Introduction

The social shaping (e.g. MacKenzie and Wajcman, 1985b) approach to an understanding of technology seeks to broaden conceptions of technology. Rather than merely addressing the "effects" and "impact" of technology, the approach demands an answer to the question:

> What has shaped the technology that is having "effects"? What has caused and is causing the technological changes whose "impact" we are experiencing? (MacKenzie and Wajcman, 1985a, p.2)

The approach cautions against the potentially dangerous simplification of "technological determinism". This opens up the possibility of new ways of viewing the technological.

> Our technology becomes, like our economy or our political system, an aspect of the way we live socially. It becomes something whose changes are part of wider changes in the way we live. It even becomes something whose changes we might think of consciously shaping - though we must warn right at the beginning that to say that technology is socially shaped is not to say that it can necessarily be altered easily. (ibid. p. 3)

The definition of technology mobilised in this literature is broad, encompassing artefacts, what people do with those artefacts, and what people know. The demands of the approach do not entail an abandoning of research on the effects of technology on society, rather the approach seeks a balance, with "at least equal time for the study of the effects of society on technology" (ibid. p.2). This call for a balance mitigates against another extreme position, that of social reductionism. It seeks a mode of analysis that is both open to, and cognizant of, the social in the technological and the technological in the social. An exclusionary emphasis on the "effects" of technology is counterbalanced by consideration of the "effects" of society. The question to be answered is whether or not such an approach can enable a synergy of positions, an understanding of the world that is not dependent upon the twin simplifications of social reductionism and technological determinism. Or does it merely degenerate into "reciprocal accusation of myopia between sociology and what (for the purposes of brevity) I will call STS (science, technology and society)" (Law, 1991a).

There are two key objections to such a balancing act. The first concerns the indictment of social science on the grounds of its "speciesism" (see, for example, Law, 1986; 1991a; 1991b; Woolgar, 1991; Callon, 1986; 1991; Latour, 1986; 1987; 1988; 1991); its ignorance of machines.

> The problem has something to do with the absence of a method for juggling simultaneously with <u>both</u> the social <u>and</u> the technical. Sociologists.. tend to switch registers. They talk of the social. And <u>then</u> (if they talk of it at all which most do not) they talk of the technical. And, if it appears, the technical acts either as a kind of explanatory <u>deus ex machina</u> (technological determinism). Or it is treated as an expression of social relations (social reductionism). Or (with difficulty) the two are treated as two classes of objects which interact and mutually shape one another. (Law, 1991a, p. 8)
>
> We are dealing with a form of distribution built deep into sociology - the distribution between people on the one hand, and machines on the other. (ibid. p. 8)
>
> Sociology may know about class, or about gender. But how much does it know about speciesism - the systematic practice of discrimination against other species? And how much does it know or care about machines? (ibid. p. 6)

Technology is not <u>determined</u> by the social order and the social order is not <u>determined</u> by technology. Law (1991a) conceives of this problem as one of "heterogeneity" and sees in it a re-presentation of the age old "problem" of the social order. The solution to such a problem is to "find a way of talking about the-social-and-the-technical, all in one breath" (ibid. p. 8).

> The social order is not a social order at all. Rather it is a <u>sociotechnical order</u>. What appears to be social is partly technical. What we usually call technical is partly social. In practice nothing is purely technical. Neither is anything purely social... [W]herever we scrape the social surface we will find that it is composed of networks of heterogeneous materials. (ibid. p. 10)

The social shaping approach sensitises us to these issues but provides only a partial solution. As a slogan and research programme it does allow a counterbalancing of the more prominent but often implicit diagnoses of technology's "effects". But by so doing it can serve to perpetuate the "switching of registers" and "speciesism" identified by Law. It does not, in itself, provide "a way of talking about the-social-and-technical, all in one breath".

The second objection to a register switching approach is the claim that the very use of the terms "society" and "technology" can play fundamental roles in the shaping of sociotechnical networks (Latour, 1988; 1991; Callon; 1991; Bloomfield and Vurdubakis, 1992). "Society" and "technology" may be seen as rhetorical devices that seek to structure and obtain a reality in the process of network building. The success of conceiving of and creating a reality using such terms is one of the outcomes that requires description and explanation. The terms cannot therefore function as explanatory variables themselves. As Latour (1988) puts it:

> Technology and society are two artefacts created by the analysts' duplicity. (p. 22)
>
> This is why, instead of the empty distinction between social ties and technical bonds, we prefer to talk of association. To the twin question "is it social?/is it technical"' we prefer to ask "is this association stronger or weaker than that one?" (Callon and Latour, 1981; Latour, 1986; 1987) (p. 27)

An Associology of Translation?

The solution proposed to this problematic by writers such as John Law, Bruno Latour and Michel Callon is to apprehend the (re)construction of the sociotechnical through the notion of translation. The approach is predicated upon three core principles:

> agnosticism (impartiality between actors engaged in controversy), generalised symmetry (the commitment to explain conflicting view points in the same terms) and free association (the abandonment of all a priori distinctions between the natural and the social). (Callon, 1986, p. 196)

Thus, the researcher seeks to account for the (always temporary) stabilisation of a sociotechnical network through consideration of the elements that make up that network and the relations that hold them in place. This task must be undertaken with the three principles outlined above in mind. The researcher must be alive to the fact that the designations and descriptions of entities and their relational links provided by actors involved in the network building process are themselves an important facet of that network building process.

> Instead of imposing a pre-established grid of analyses upon these, the observer follows the actors in order to identify the manner in which these define and associate the different elements by which they build and explain their world, whether it be social or natural. (Callon, 1986, p. 201)

The terms used to explain [1] the (re)production of a sociotechnical network are primarily actors and their translations. Actors (be they "social" or "technical") are accorded agency in such an approach. Thus one witnesses the mutual translation of actors by other actors. Actors in this sense are attributed a quasi-reality; they are seen as quasi-objects (see Serres, 1987) since the designation, description and prescription of actors is part and parcel of the process of translation. Utilising a linguistic analogy, Latour proposes consideration of actors or entities in terms of texts or statements. Actors and their network building programs are "read" by other actors and through this reading process both the readers and the text are transformed. Thus,

> we are not to follow a given statement through a context. We are to follow the simultaneous production of a "text" and a "context". (Latour, 1991, p. 106)

> we never work in a world filled with actors to which fixed contours may be granted. It is not merely that their degree of attachment to a statement varies; their competence, and even their definition can be transformed. These transformations undergone by actors are of crucial importance to us.. because they reveal that the unified actor is itself an association made up of elements which can be redistributed. (ibid., p.109)

Indeed, the extent of agreement between various actors' readings of each other provides us with an indication of the "reality" of the network that they constitute. "Reality" is the outcome of network building. In the process of translation reality is created as "the identity of actors, the possibility of interaction and the margins of manoeuvre are negotiated and delimited" (Callon, 1986, p. 203). Or to put it another way, considering translation allows us to apprehend..

> the simultaneous production of knowledge and construction of a network of relationships in which social and natural entities mutually control who they are and what they want. (ibid., p. 203)

The Translation Process

Callon (1986) identifies four "moments" of translation, although he is at pains to point out that they do not necessarily occur in a tidy sequence (see also Knights et al, forthcoming, who attempt to apply this approach to understand the construction of a computerised "network"). Through translation actors attempt to impose themselves and their definition of a situation on the other actors implicated in that definition. In the first moment, a primary actor [2] problematizes (Callon, 1986) an issue. The "problems" and identities of other actors are defined in such a way as to render the enunciator as an "obligatory passage point" (Callon, 1986). The enunciator defines others and their situation in order to become indispensable to both. The network of relations, or solution to other actors' "problems", can only be constructed through the enunciator. Thus the enunciator defines for itself an integral role in the construction of its product (the network) and defines this product as the solution to a problem; a defined problem for defined other actors.

> problematization describes a system of alliances or associations, between entities, thereby defining their identity and what they "want". (Callon, 1986, p. 206)

However, as we noted above, all the entities or actors that describe a network are themselves granted agency in an account based upon translation. And thus, potentially, they may not agree with the designation provided by the primary actor in the problematization statement. The primary actor must work to establish the identities and relations as they are rendered in the problematization. This work is termed <u>interessement</u> (Callon, 1986).

> Each entity enlisted by the problematization can submit to being integrated into the initial plan, or inversely, refuse the transaction by defining its identity, its goals, projects, orientations, motivations, or interests in another manner. In fact the situation is never so clear cut. As the phase of problematization has shown, it would be absurd for the observer [or researcher] to describe the entities as formulating their identity and goals in a totally independent manner. They are formed and are adjusted only during action.
>
> Interessement is the group of actions by which an entity.. attempts to impose and stabilize the identity of the other actors it defines through its problematization. (ibid. p. 207 - 8)

In essence, the method by which actors interesse other actors is through the building of devices or networks which can be placed between the actors to be interessed and "all other entities who want to define their identities otherwise" (ibid. p. 208). These notions of political analysis and (re)synthesis reveal the strategic nature of network building. And as Callon notes:

> The range of possible strategies and mechanisms that are adopted to bring about these interruptions is unlimited. (ibid. p. 209)

Pejorative pre-definitions of possible strategies and mechanisms would violate the spirit of the translation approach. These strategies are defined <u>in situ</u> and are predicated upon interpretations of what those actors yet to be enrolled want and how they are currently defined through their associations with other entities.

> [I]nteressement helps corner the entities to be enrolled. In addition, it attempts to interrupt all competing associations and to construct a system of alliances.. [S]tructures comprising both social and natural entities are shaped and consolidated. (ibid. p. 211)

<u>Defining and Co-ordinating Roles: The Process of Enrolment</u>

As we noted above, the "identities" and "links" formed during the process of interessement are always contingent and thus potentially temporary in their effects [3]. The extended problematization and interessement process: the definition of actors and their putative links with each other; does not necessarily lead to firmer alliances between those entities. The effort to bond described/ascribed entities together is termed by Callon the phase of <u>enrolment</u>. "The issue here is to transform a question into a series of statements which are more certain" (ibid., p. 211). Enrolment is the successful outcome of the problematization and interessement process. It entails a number of conflicts or battles between entities in a struggle to convince them to play the roles to which they are ascribed. As Munro and Kernan (1993), following Latour (1987) note, the process of enrolment entails the re-presentation of the interests of (potentially) interested others (see also, Robson, 1993). Describing the overall process of translation, Latour suggests that..

> it means that one version [of (putative) reality] translates every other, acquiring a certain hegemony: whatever you want, you want this as well. (1987, p. 121)

Such a statement aptly describes the microcosm of translation that Latour and Callon term enrolment. Without the adoption of such an approach the Machiavellian nature of the translation process would simply be too visible to the entities ascribed roles by the enunciator.

> To establish a functioning network entails a <u>translation</u> of the interests of others into one's own interests. Translation, however, should be conducted in ways which make one indispensable to others and render <u>their</u> detour invisible to themselves (Latour, 1987, p. 108 - 121). The desired effects of translation are first, <u>control</u>, in that the work of others acts to propel one's own interest and, second, <u>invisibility</u>, in that one's own interests can successfully be re-presented in the name of others. (Munro and Kernan, 1993, p. 2, emphasis in original) [4]

Through the process of enrolment a number of entities and putative networks engage in trials of strength that seek to instantiate the network of entities rendered in the problematization of the enunciator. If the enunciator's definitions are relatively victorious, the other entities are successfully ascribed/described, or enrolled within the relational network set in motion by the enunciator. However, once enrolled the entities and the network they make up must be <u>mobilised</u> to act in the interests of the enunciator. In the next section we examine how Callon (1986) apprehends the notion of <u>mobilisation</u>.

Mobilising Enrolled Entities to Act for the Enunciator

The issue of representation, so far raised only obliquely and largely implicitly in our account of translation, takes centre stage in the phase of mobilisation. Although, as this thesis attempts to demonstrate, the notion of re(-)presentation may be seen to be a key resource in the apprehension of the entire translation process. Munro and Kernan's (1993) account of translation provides a crossover between the processes of enrolment and mobilisation. And consideration of representation allows us to examine some of the dangers of the translation approach. These will be dealt with after a brief consideration of the role of representation in the process of mobilisation.

For the "power effects" (see Foucault, 1977a; 1978; 1991) of the enunciator's network to accrue, the entities enrolled or re-presented in the network must not contradict their representation in that network. To put it bluntly, if the entities present themselves in ways discordant with their re-presentations in the emergent network the programmatic ambitions of that network will remain unfulfilled. Or to use Latour/Callon's terminology the network will be translated from its rendering by the enunciator.

> To speak for others is to first silence those in whose name we speak.
>
> [C]hains of intermediaries which result in a sole and ultimate spokesman can be described as the progressive mobilisation of actors who render.. [certain] propositions credible and indisputable by forming alliances and acting as a unit of force. (Callon, 1986, p. 216)

> The notion of mobilization is perfectly adapted to the mechanisms.. described. This is because this term emphasizes all the necessary displacements. To mobilize, as the word indicates, is to render identities mobile which were not so beforehand.. Through the designation of the successive spokesmen (sic.) and the settlement of a series of equivalencies,.. actors are first displaced and then reassembled at a certain place at a particular time. This mobilization or concentration has a definite physical reality which is materialized through a series of displacements (Law, 1985b). (Callon, 1986, p. 216 - 7)

Mobilization is the outcome of a successful and successive process of <u>decontextualisation</u> from prior relations coupled with subsequent <u>recontextualisation</u> in the emergent network (see also Letiche, 1993). Network building, the establishment and stabilisation of entities and their relations, entails the simultaneous construction of text and context (Latour, 1991). Entities are re-presented through a process of description/ascription that (temporarily) re-defines their essence in terms of the demands and relations of the network in which they are to be mobilized. The (successful) result is a functioning network of acting entities mobilized in support of the enunciator [5]. There is still, however, no guarantee that these mobilizations will persist. Various entities may betray their network as they seek and achieve enrolment in counter networks.

<u>The Role of Re(-)presentation</u>

Woolgar (1991) provides some illustrative comments on the links between the notions of representation and translation, although the latter term is not explicit in this account. Woolgar is particularly interested in the role played by putative boundaries in any process of sociotechnical stability or change. He notes that:

> Much of our mundane discourse.. presupposes and exemplifies the assumption that the characteristics of an entity can be associated with a particular bounded space. (1991, p. 63)

By problematizing these notions of boundary/boundedness Woolgar is able to challenge their necessity (see also Hines, 1988). This opens up space for a form of analysis that doesn't take entities as given. Rather entities are to be conceived as <u>quasi-objects</u> (Serres, 1987) and one is able to throw "into relief one of the foundational ordering principles of our phenomenal world: the presumption that entities are bounded" (Woolgar 1991 p. 64). One may see, from such a perspective, not only the general form of the presumption of boundedness as "both culturally and historically relative" (ibid. p. 64). Specific forms of the representation of entities in more or less putative sociotechnical networks may also be seen to exhibit such relativity. Given such an understanding one obvious question springs to mind: What are the power relations that produce such effects?

For Woolgar the problem is solved through the invocation of what he terms "The Moral Order of Representation" (Woolgar, 1989; 1991).

> we can refer to any existing complex of relationships as the moral order of representation (Woolgar, 1989). It is a world view which embodies notions about the character and capacity of different entities, the relationship between them, their relative boundedness, and the associated sanctioned procedures for representation. Thus, one knows and can adequately represent the views of any one entity in virtue of how it relates to and differs from others in the matrix. (Woolgar, 1991, p. 66)

From such a perspective the moral order of representation is seen to be productive of reality. The power effects of the moral order are visible in the reality so created. It is worth noting here how such a view on representation takes us close to the Foucauldian conception of discourse discussed in the following chapter.

Re(-)presentation, Mobility, and Technology

Cooper (1992, 1993) has also addressed the intertwinings of technology and representation (see also Lynch and Woolgar, 1988).

> Technology and representation are immemorially connected. (Cooper, 1993, p. 2)

He notes that for the ancient Greeks techne described the process of realisation, the art of making present. However, the modern conception of technology is seen to entail a "curious twist" in meaning.

> Instead of the concern with making present, with the art of constructing something for the apprehension of the senses, the modern interest in technology puts the stress on immediacy of use, constant availability and the easing of effort. (ibid.,p. 2)

Modern technology is seen as re-presenting...

> actions in space and time according to an economics of mastery and control. (ibid., p. 2)

Cooper examines the archaeology of the word techne to reveal its derivation from the old Greek tuche, "meaning chance, fate, or that which lies beyond human control" (ibid., p. 2). Thus techne is seen as that which turns chance to advantage. For Cooper modern technology is seen to differ from the ancient techne in terms of its degree of detachment from the vagaries of the natural world.

> Ancient _techne_ was directly dependent on the powers and contingencies of the natural world; it took advantage where it could. Modern technology, in contrast, is distinguished by its detachment from nature and this separation enables it to increase its advantage at will. (ibid., p. 3)

This advantage is seen to derive from the moral order of (modern) representation and its associations with the (modern) technological project.

Following Foucault (1977), Cooper conceives of the body as a key source of _tuche_ and an ongoing (potential) impediment to the realisation of the power effects of human agency. The certainty and detachment that agency requires are undermined by the instability of the body: "a volume in perpetual disintegration" (Foucault, 1977b, p. 148 quoted in Cooper, 1993). Thus for Cooper:

> All representations originate in the instability of the body. All _techne_, all making, flows from this need of the body to re-present itself in terms of more durable external structures. (ibid., p. 3)

Cooper draws upon Scarry's (1985) insights into the "counterfactual structure" of representation/technology. Through this structure representation re-presents. "Inadequacies" of the body are apprehended in such a way that the process enables their turning to advantage.

> Representation thus involves two complementary steps: (1) the separation and objectification of bodily attributes and (2) the recovery by the body of the objectified attributes in an act of self-appropriation.
>
> A major consequence of the body being able to represent itself in external artifacts is that the human agent can more easily control and modify the latter than it can its own body. (Cooper, 1993, p. 4 - 5)

This move enables a detachability of bodily attributes, parts and functions. Thus, the re-presented body is open to re-design and recombination. The body as "a volume in perpetual disintegration" is not so (easily) open to such processes. The relative stability of the "self" (Foucault, 1978) is required to act as overseer and manipulator (or manager) of the world and body.

> If you can't change the world. Change yourself.
> And if you can't change yourself then...change the world.
> (Johnson, 1992)

With the advent of industrial production this process is accelerated and qualitatively altered. The world is represented as, and hence shaped into, a stock of parts that can be recombined at will. Objects, or re-presentations lose their "essence", derived from the specifics of their bodily appropriation, and take on a mode of being that is metaphorically exemplified by Lego and Mechano.

> The detachability of bodily parts and functions enables an ars combinatoria to be applied to the act of representation... The whole object, formerly a creation of techne, "now becomes a transient aggregate given to assembly, disassembly and reassembly" (Fisher, 1978, p. 142). (Cooper, 1993, p. 5)

Drawing on the work of Heidegger (1977) and Latour (1987), Cooper notes that the appearance of detached representations is productive of a new form of power. A power that enables a view of the world "as a table top ruled by the human hand and eye" (Fisher, 1978, p. 144). Without detached representation entities would not be mobile and hence mobilizable. Thus we see that detached representation is a pre-requisite of translation.

Just as bodily re-presentation enables "solutions" through the appropriation of "problems", modern technologies of representation enable power/knowledge effects through their appropriation of re-presented items on a grander scale [6]. (See for example the excellent paper by Law (1986b) concerning the Portugese expansion).

> modern technologies of representation <u>know in advance</u> by simulating within themselves all the critical features of the external conditions they seek to control. (Cooper, 1993, p. 8-9)

Modern technologies/representations produce power by constructing and colonising a place called the future through their "technical" detachment from, and colonisation of, the "lifeworld". However, there is a price to be paid. For such a system to function effectively the world must be changed "in the direction of representational convenience so that the world becomes more like our representations and less like the world" (Cooper, 1993, p. 10). As Vickers (1970) puts it, such a system provides us with something akin to "freedom in a rocking boat".

> Pressed to its extreme, this process tends towards finality through the construction of large-scale systems of certainty which seek to master what remains of uncertainty; a continuous chain of terms is forged which must reinforce each term's certainty. Heidegger calls this process "the gigantic". (Cooper, 1993 p. 13 - 14)

But such a process is like a dog chasing its tail. The attempt to trap all uncertainty in the world tends towards an overall world system. As a result everything is dragged closer together and made smaller. The world becomes displaced and abbreviated in order to facilitate remote control (Cooper, 1992; see also, Roszak, 1986; Zuboff, 1988).

> Here, everything is doubled on itself - the big becomes the small, the strange becomes the familiar, what is far becomes near. All detachment becomes attachment. It is the return of tuche. (Cooper, 1993, p. 14)

Weber (1992) makes a similar point when considering the specific technology of television. Television can only live up to its name and set before us the certainty of distant events through the re-ordering of the world and the certainty expunging "doubling" that televisual systems entail. As Weber puts it "it sets only by unsettling" (p. 15). The diffusion of information technology may be seen as another classic example of this process at work. The deployment of IT holds out the dream of grasping the uncertainty created by its dispersal (see also Robb, 1990; 1993). This is a theme we return to in the next chapter.

Cooper (1993) conceives of this tuche returning characteristic of modern technology/representation, following Heidegger (1977) and Foucault (1970; 1977a) in terms of the spatial logic of the fold. The return of tuche marks a shift from representation to simulation.

> despite the never ending effort of representation there is always the fold that refuses unfoldment. (Cooper, 1993, p. 28 - 29)

Foucault (1970) notes the impossibility of representing representation. This tail chasing nature of modern representation/technology is what gives rise to simulation.

> The real is produced from miniaturised units, from matrices, memory banks and command models - and with these it can be reproduced an indefinite number of times.. In fact, it is no longer real at all. It is hyperreal, the product of an irradiating synthesis of combinatory models in a hyperspace.. the age of simulation thus begins with a liquidation of all referentials. (Baudrillard, 1983, p. 3 - 4, quoted in Cooper, 1993, p. 30)

> Simulation has gone beyond the stage of detachability.. which enabled the world to be manipulated as "transient aggregates given to assembly, disassembly and reassembly", by abolishing the very notion of a substantive reference. (Cooper, 1993, p. 30 - 31)

Representation gives way to simulation (see also, Roszak, 1986). The recalcitrance of the world provided the representation process with continual grounds for its perpetuation (see Zuboff, 1988). With the emergence of simulation the "system" becomes self sustaining. "Simulation folds back on itself in.. [a] process of dedifferentiation" (Cooper 1993 p. 31). The project has a self-collapsing characteristic of "implosion" (Baudrillard, 1983) which inevitably leads to the undermining of the rigidities of categorical thought upon which representation depends. Technology and it's representational and simulational objectives become the source of uncertainty rather than its solution [7]. The world functions as a gigantic simulacrum (Baudrillard, 1983).

> Simulation, for Baudrillard, thus appears as a quasi-representation whose stability is constantly threatened by its dividedness or reversible imminence. (Cooper, 1993, p. 40)

The "congenitally failing" nature of managerial practices and technologies (Miller and O'Leary, 1993; Lilley, 1993; see also Munro and Kernan, 1993; and MacIntyre, 1985) may thus be seen as a consequence of the logic of representation and its degeneration into simulation.

> Managerial expertise, and the government of the enterprise more generally, is a congenitally "failing" activity to the extent that a succession of programmes is the norm rather than the exception. (Miller and O'Leary, 1993).

We return to these themes when discussing the empirical material presented in this thesis in a later analytical chapter. To conclude our survey of the tools for surveillance of the system we consider the dangers associated with an associology of translation.

Apprehending Translation From the Safety of the Veranda

> To speak for others is to first silence those in whose name we speak. (Callon, 1986, p. 216)

Such a comment is just as applicable to those who attempt to understand the translation process from "outside" as it is to those involved entities we seek to understand. This thesis seeks to account for the transformation of a sociotechnical network at and surrounding BP Oil's Grangemouth Refinery. It utilises accounts of that process provided by organisational participants. It attempts to reveal their translations of a variety of representations (simulations?) in this process of network (re)building. It reveals how the entities that make up this network, and the network itself, are realised through the "simultaneous production of.. 'text' and.. 'context'" (Latour, 1991, p. 106). But what of this thesis itself? What happens when the associologist takes a reflexive turn? What is the "truth" of the account provided in this thesis? What is its context? What "interests" are imputed to the re-presented (simulated) entities? Would they (if they could) represent themselves in the same way? What are the interests of the entity termed "author"? [8].

> The function of representation is to translate difficult or intransigent material into a form that facilitates control. (Cooper, 1992, p. 255)

The re-presented accounts of organisational participants that form the "empirical" basis of this thesis are translated by the author in order that they may be bent to his will, to his objectives [9]. Most obviously these objectives entail a relatively easy passage through the rituals of examination (Foucault, 1978) or inspection (Meyer and Rowan, 1977) in order to grant himself access to the academic priesthood. But there is plenty of space for action within such an objective. Objectives are further honed, but not determined, by the choice of examiners and the specific form of "priestliness" desired. These choices too are informed by more or less traditional "political", "social" and "economic" objectives [10]. However, in the logics of simulation and translation such statements do not provide answers, they merely serve to generate further questions in a "gigantic" list. Perhaps in the best traditions of interest analysis (see Robson, 1993) the solution to this problem lies with others as they extend the chain.

> actions [are] explained by.. interests; interests are revealed by.. actions. (Robson, 1993, p. 5)

Although empirical demonstration of interests may be theoretically tautological (Hindess, 1986; 1988) such practices are not pragmatically closed. New interests are imputed and new actions observed as a Whiggish history (re)assesses the text. Despite my attempts to "configure" (Woolgar, 1991) the reader, the destiny of this text and imputations ascribed to it are (largely) beyond my control.

> The fate of a statement is in the hands of others. (Latour, 1991, p. 105 - 106)

In one sense these objections matter little - social scientists are continually chastised for their views from the veranda or ivory tower. The associology of translation and consideration of issues of representation and simulation merely serve to make these issues more explicit. It is not that they are absent from other approaches, just less explicitly acknowledged. This leads us to the other sense of the objection. Associology, in making these points explicit, should make some attempt to deal with them. We must accept that to produce an account of entities entails a further representation/simulation of those entities. Undoubtedly, we must give up pretensions to "truth". But we must also seek to produce an account that is workable, that will "hold", in the network of entities that constitute the readership of that account. How do we provide a "reasonable" account?

Callon (1986) provides us with some way forward. We must attempt to be faithful to the methodological principles seen to underlie an associology of translation: agnosticism, generalised symmetry, and free association. Still, the reader has little guarantee, the "quality control" of the text is a slippery eel.

> Having opted in this text for a vocabulary of translation we know that our narrative is no more, but no less valid, than any other.. Our hope is that the translation repertoire, which is not that of the actors studied, will convince the reader. (Callon, 1986, p. 200)

To make visible the translations implicit in the production of this thesis, in an attempt to convince the reader, a number of secondary methodological principles have been adhered to. The middle section of this thesis provides an account of the translation process in the terms of the actors involved, in their own repertoires. An attempt has been made to assemble a rich picture of the processes involved. Entities who "spoke" to the researcher are quoted at length and a minimal commentary is provided that seeks to link these snippets of organisational participants' accounts. Other entities, through their re-presentation (simulation) in these accounts speak only at a distance, their own voices silenced in the process. But this silencing is never complete, unworkable renderings are negotiated away as their inoperability is revealed, or work is done to alter notions of operability. All the entities enrolled in the account seek to speak for themselves and the author has, as far as possible - given the institutional demands on thesis production, tried to help them to do so.

Snippets of accounts are derived from taped interviews, carefully noted interviews where taping was impossible, and both internal and external company documentation. The researcher gained access to the refinery, the wider BP Group and their participant members, through contact with the refinery's Information Technology Superintendent. Ostensibly the researcher presented himself as interested in the organisational and business issues surrounding large scale system implementation and use. Thus, interviewees were asked to account for the system and its relations with their jobs and the wider purposes of the organisation. Most interviewees were comfortable with such a task. Some may have used the interviews as a method of serving their interests by making anonymised soundings about the system but all such attempts are grist to the mill of an associological approach. Attempts to account for the system "disingenuously" were apprehended but not ignored by comparison of a variety of sources of accounts.

Whilst these sources may be acceptable, themes and statements within them have been mobilized by the author. That is, they have been decontextualised from their relations of production and recontextualised to meet the demands of the story constructed in the thesis. The author's activities were informed and sensitised in this respect by the principles of translation outlined above, but were obviously not entirely determined by such an orientation. Judgements of the adequacy of these attempts are still, unavoidably, in the hands of the readers. Little more can be said. Still, one set of questions remains. What's it all about? What's the point? In terms of the logic of mastery underlying modern technology/representation/simulation, what does the approach enable?

Associology and Judgement

The relativity inherent in an approach based upon translation and representation/simulation suggests superficially that there is no room left for judgement. Such a characterisation only holds under the mirage of epistemological transcendence and certainty. As Latour puts it:

> In order to make a diagnosis or decision about the absurdity, the danger, the amorality or the unrealism of an innovation, one must first describe the network. If the capability of making judgements gives up its vain appeals to transcendence it loses none of its acuity. (1991, p. 130)

The approach allows us to juxtapose representations/simulations provided by a number of authors to ascertain their convergence. We can glimpse the construction of reality at work as certain power effects and relations are established. It allows us to challenge the necessity of these arrangements and demonstrate the contingent nature of their perpetuation.

> The repertoire of translation is not only designed to give a symmetrical and tolerant description of a complex process which constantly mixes together a variety of social and natural entities. It also permits an explanation of how a few obtain the right to express and represent the many silent actors of the social and natural worlds they have mobilized. (Callon, 1986, p. 224)

And as Callon notes, such a position makes visible the links between the approach and "the notion of the political economy of power proposed by Michel Foucault" (ibid., p. 230). We investigate the possibilities of a Foucauldian orientation in the next chapter.

NOTES AND REFERENCES

1. In the account provided in following chapters and in the sociology of translation more generally, description slides into explanation. To quote Latour again:

> Explanation does not follow from description; it is description taken that much further. (Latour, 1991, p. 121)

2. Or the enunciator of a statement (Latour, 1991); a Prince (Latour, 1988); an heterogeneous engineer (Law, 1985a); or a system builder (Hughes, 1983).

3. As should be abundantly apparent by now, all networks are to be seen as temporary, contingent stabilisations. However, in the terms of translation, entities that are enrolled are seen to be more tightly bonded and more "permanent" than those that are merely interessed.

4. One should not forget that defining one's own interests and the interests of others entails the mutual definition of oneself and one's others, both in terms of their otherness and sameness, and in terms of a presupposed essence or nature.

5. One must bear in mind that it is likely that the enunciator and its enunciation will have also been translated through this process. Translation entails negotiation between putative entities in the mutual mediation of a workable network. Workable is an operative word here. As Latour (1987) puts it, the truth or reality of a network are the effects of enrolment. These relations are "true" because they hold. That is they are workable and will remain "true" for as long as they remain workable.

6. As we noted earlier: "All representations originate in the instability of the body". It is the extension of this process and recombination of the subjects/objects so produced that distinguishes modern technologies/representations.

7. See also Perrow's (1984) conception of "normal accidents".

8. I am grateful to Fenton Robb and Peter Case for explicitly drawing the importance of these questions to the forefront of my attention.

9. Such a characterisation of the thesis production process entails an assumption of a highly centred subject as author. It should be abundantly clear by now that this assumption is untenable. The author and his interests have undoubtedly been translated through his interaction with the material.

10. Sociotechnical objectives?

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CHAPTER THREE

A SELF FULFILLING DISCOURSE? : A NEW COMMERCIAL AGENDA FOR A NEW COMMERCIAL WORLD

Introduction

This chapter briefly considers recent publications concerning both changes in the commercial environment and changes in what is deemed to be the "appropriate" way to conduct business in such an environment. It is suggested that these two bodies of work have together brought about a sea change in the commercial world. That is, regardless of the "reality" underlying initial contributions to the debate, the complementarity of the analyses and prescriptions provided by this literature is such that the conditions and actions originally "described" are necessarily (re)produced by the diffusion of the themes set out in the texts. These strands of literature form a self fulfilling body of work.

The chapter seeks to examine how the themes of this literature have gained ascendancy in the commercial world. How have the old watchwords of effectiveness, efficiency and economy been supplemented and/or transformed, and what are the implications of the new watchwords that are emerging to reinforce and replace them? New themes, such as flexibility, quality, and culture are deployed in rationalisations of organisational activity provided by organisational participants and hence the ways in which these themes are used may be expected to play a significant role in the shaping of organisational artefacts.

Considering the pre-eminent position afforded to information and communication technologies in this literature, the shaping role of these themes on computerised information systems and the wider networks in which they are embedded would seem to be particularly significant. And, as we noted in the previous chapter, this shaping is unlikely to be unidirectional.

The Concept of Discourse

In order to explicate these changes the chapter draws upon the insights offered by the Foucauldian conceptualisation of discourse. In common sense terms a discourse is simply a coherent body of speech or text. In Foucauldian terms "..a discourse is a group of statements which provide a language for talking about - i.e. a way of representing - a particular kind of knowledge about a topic" (Hall, 1992, p.291).

> A discourse is similar to..an "ideology": a set of statements or beliefs which produce knowledge that serves the interests of a particular group or class. Why, then, use "discourse" rather than "ideology"?
>
> One reason which Foucault gives is that ideology is based on a distinction between true statements about the world (science) and false statements (ideology), and the belief that facts about the world help us to decide between true and false statements. But Foucault argues that statements about the social, political or moral world are rarely ever simply true or false; and "the facts" do not enable us to decide definitively about their truth or falsehood, partly because "facts" can be construed in different ways. The very language we use to describe the so-called facts interferes in this process of finally deciding what is true and what false. (Hall, 1992, p.292)

The Althusserian conception of Ideology is perhaps the most "productive" rendering of this notion. Ideology (Althusser, 1970; 1971) is seen to be productive of subjects through a process of subjectification. The results of this process, subjects and objects, are seen to be made so evident by the action of Ideology that the imaginary nature of the process itself is hidden through an act of misrecognition. Ideology, the evidentness of subjects and objects, is seen to be imaginary in respect to (true) knowledge. Such a position is derived from the materialist project of Marxist thinking and the associated dichotomy between science and illusion. Conversely, Foucault does not seek to arbitrate between "true" and "false" discourses. Foucault's analytical strategy is based upon...

> the methodological postulate that there is no meaning to discourses beyond what they say; it implies a denial of the general categories of illusion or misrecognition (Cousins and Hussain, 1986, p. 178)

Foucault's aim is to investigate...

> ...historically how effects of truth are produced within discourses which in themselves are neither true nor false. (Foucault, 1980, p.118)

According to Foucault, it is power, not "facts" about reality, which makes things "true". Thus, if two discourses are in competition, with both producing knowledge attempting to provide a "true" depiction of reality, one may assume that each of the discourses is linked to a contestation over power. It is the outcome of the struggle over power that will arbitrate the truth.

> [T]ruth isn't the reward of free spirits, the child of protracted solitude, nor the privilege of those who have succeeded in liberating themselves. Truth is a thing of this world: it is produced only by virtue of multiple forms of constraint. (Foucault, 1980, p. 131)

> We should admit that power produces knowledge... That power and knowledge directly imply one another; that there is no power relation without the correlative constitution of a field of knowledge, nor any knowledge that does not presuppose and constitute... power relations. (Foucault, 1980, reproduced in Hall, 1992, p.293)

So what is power in the Foucauldian sense? A relationship of power...

> ...is a mode of action which does not act directly and immediately on others. Instead it acts upon their actions: an action upon an action, on existing actions or on those which may arise in the present or the future. (Foucault, 1982, p.220)

The conceptualisation of power employed by Foucault is not one of a purely negative, repressive and prohibitory force. Rather, power is seen to be productive and creative and Foucault seeks to describe a positive "economy" of power. Through their power effects discourses not only constrain but also enable action. Indeed, power may be said to <u>distinguish</u> (Robb, personal communication) appropriate actions. Discourses create and order representations. And representation enables and prefigures action through the prior retrieval of critical aspects of the "future" into representational space. A purely negative power would be sorely limited in its potential.

> If power were never anything but repressive, if it never did anything but to say no, do you really think one would be brought to obey it? What makes power hold good, what makes it accepted, is simply the fact that it doesn't only weigh on us as a force that says no, but that it traverses and produces things, it induces pleasure, forms knowledge, produces discourse. It needs to be considered as a productive network which runs through the whole social body, much more than as a negative instance whose function is repressive. (Foucault, 1980, p.119)

It is the intention of this account to suggest that managerial technologies are particularly significant products of managerial discourse. This importance, in large part, derives from the (partial) irreversibility of "technology" (Callon, 1991; Latour; 1991; Winner, 1977; 1985) and its concomitant pre-supposed neutrality and inevitability. The "duplicity" of a segregation of technology from the social enables its partial insulation from political interrogation.

Discursive Coherence

A discourse consists of a number of statements that together constitute a discursive formation. These groups of statements have a coherence that does not derive from shared authorship, or from shared meanings or intentions underlying the texts. Their unity results from

> ...the presence of a systematic dispersion of elements. Where between objects, types of statements, concepts and thematic choices there exists an order, correlations, "positions in commonspace, reciprocal functioning" (Smart, 1985, p.39)

This unity reveals a "moral order of representation" (Woolgar, 1991). The statements hold together as a formation (or "network", Callon, 1986; 1991, Latour, 1987; 1991) because each of the statements implies a relation to all the others. Discourse constitutes the construction, interplay, and self reflection of representational entities. Discursive statements are mutually dependent and reciprocally linked.

> They refer to the same object, share the same style and support "a strategy ..a common institutional.. or political drift or pattern". (Cousins and Hussain, 1984, pp. 84 - 85)

The systems of rules, regularities and relations that govern the formation and perpetuation of a discourse are not conceived of as constraints "emanating from the consciousness or thoughts of a sovereign subject nor are they determinations arising from institutions, or social or economic relations" (Smart, 1985, p. 39). These "rules of formation of statements" (Foucault, 1980, p.112) are located by Foucault at the "prediscursive" level. They are the unquestioned assumptions and bases of our way of going on in the world. The continuation of "normal service" is predicated upon the perpetuation of these "conditions of possibility" of the discourse. The rules of formation of a discourse are the inaccessible and unquestionable self evidences that are drawn upon in our language and practices and in our thoughts and actions and maintained through our participation in these activities. They constitute..

> what must be related, in a particular discursive practice, for such and such an enunciation to be made, for such and such a concept to be used, for such and such a strategy to be organized. (Foucault, 1972, p.74)

These systems of formation are not immobile, they do not constitute "static forms that are imposed on discourse from the outside...that define once and for all its characteristics and possibilities" (Foucault, 1972, pp.73 - 4). They...

> reside in discourse itself; or rather..on its frontier, at that limit at which the specific rules that enable it to exist as such are defined. (Foucault, 1972, p.74)

The notion of discourse is not predicated upon the conventional (artificial) distinction set up between language and thought on the one hand, and action and practice on the other.

> Discourse is about the production of knowledge through language. But it is itself produced by a practice: "discursive practice" - the practice of producing meaning. Since all social practices entail <u>meaning</u>, all practices have a discursive aspect. So discourse enters into and influences all social practices. (Hall, 1992, p.291)

The aim of this chapter is to identify and characterise the discourse providing the new organisational orthodoxy to the commercial world and hence creating and giving meaning to that world, in order that its influences on the practices of British Petroleum, and the accounts of those practices provided by organisational participants, may be examined. Thus the notions of discourse and discursive practice offer us another opportunity "to follow the simultaneous production of.. 'text' and.. 'context'" (Latour, 1991, p. 106). In order to do this a number of questions must be answered: What is this new orthodoxy, how did it emerge, and what are its implications? Foucault suggests that...

> the exercise of power itself creates and causes to emerge new objects of knowledge and accumulates new bodies of information. (1980, p.51)

The following section attempts to address the specific exercise of power implicated in the emergence of the new commercial agenda, although as we will hopefully demonstrate, from our contemporary stand point very little of this discourse appears to be "new".

The Discourse and Practices of Management

The work of Burnham (1941) provides us with a useful, if somewhat arbitrary starting point for consideration of the discourse of management. Burnham's thesis concerns "The Managerial Revolution". It is a somewhat late addition to the burgeoning literature on managerialism that emerged in the early part of the century, particularly in America. Following on from the traditions of Scientific Management (Taylor, 1947) and the Sloan school (Sloan, 1965) (see, also, Fayol, 1948) which sought to provide a theoretical basis for the emerging "profession" of management (Chandler, 1977), Burnham's account sought to situate the rise of management in a wider sociohistorical context.

Burnham suggested that following a widespread separation of ownership and control in capitalist enterprises and a technicisation and professionalisation of the discipline(s) of management, a new social group was acquiring dominance, in terms of its privileged position with regard to the control of resources. This ascendant group consisted of "those whom we call the managers" (Burnham, 1941, p. 101). Whilst nominally still in the service of capitalists, this new class of managers was seen to be in a position of potential social dominance through its <u>actual</u> rather than nominal control of resources, in particular the means of production.

> The instruments of production are the seat of social domination; who controls them, in fact not in name, controls society, for they are the means whereby society lives. (ibid., p. 102)

Burnham saw the emergent creed of managers as a new political vanguard on the verge of assuming societal control.

> [T]he managers will exploit the rest of society as a corporate body, their rights belonging to them not as individuals but through the position of actual directing responsibility which they occupy. They.., through the position of privilege, power, and command of educational facilities, will be able to control, within limits, the personnel of the managerial recruits; and the ruling class of managers will thus achieve a certain continuity from generation to generation. (ibid., p. 126)

Although the benefit of hindsight allows us to see a fair amount of exaggeration in the predictions of Burnham's thesis (see, for example, Knights et al, forthcoming), it is clear that a class that we may term managers did indeed increase in size and influence during the middle decades of this century (see, for example, Prestus, 1962; Lash and Urry, 1987; Burns and Stalker, 1966). However, the more profound implication of these changes, in terms of the arguments mobilised in our account of sociotechnical transformation at BP, is the emergence and solidification of a form of knowledge and practices, implicating a certain moral order of representation. We may term this discursive formation "management" or "managerialism". The emergence of a distinct class of managers who could potentially appropriate control of the means of production is in some senses a secondary effect, produced by, but also productive of, managerialism. For Burnham this is the primary effect of the changes he attempts to apprehend since his discourse is predicated on the notion of an a priori sovereign subject who is capable (however imperfectly) of knowing his or her interests and how to further them. In Burnham's terms for example, a rational capitalist, reading the writing on the wall, would attempt to transform him or herself into a manager.

From a Foucauldian perspective, managerial discourse may be seen to be productive of the (privileged) organisational position that we term management, and, moreover, of those (privileged) bodies that inhabit this space, that we term managers. Thus we may conceive of management as discourse, practice and person. The particular forms taken by this triptych during the middle decades of the twentieth century were congruent with, and indeed productive of, emergent forms of corporatist or Fordist sociotechnical organisation. A highly segregated and segmented large scale production process [1] was designed by a managerial function, populated with managers who were fueled by managerial understandings. Resynthesis of divided labour required an hierarchical overview provided by such understandings. The visible hand of management sought to tame the vagaries of the invisible hand of the market. Managerialism held out the promise of control of the enterprise in the corporatist market environment through the capturing of uncertainty in specific forms of re-presentation, most notably hierarchically and laterally segregated production relations. Hierarchy was legitimised as "rational" (Weber, 1947) [2] and indeed necessitated by the "bounded rationality" (Simon, 1957) of managerial subjects.

However, as we noted in the previous chapter, attempts to capture what remains of uncertainty through the endless diffusion and refining of representations that seek to facilitate control lead inevitably to an enfoldment of representation. Representational activity becomes a source of uncertainty rather than an antidote for its ubiquitous presence. In this respect, the increasing scale of the enterprise has instantiated a centrifugal separation of "professional" managerial expertise. As Robb (1993) suggests..

> Over time, different institutions have emerged from various conversations and communications addressing particular aspects of the activities in managerial organisations. This has resulted in a partitioning of managerial activities and the specialisation of these into discrete functions dividing the organisation "laterally" so that mutually dependent activities have become separated from each other by institutionalised divisions. Concurrently institutionalised interpretive schemes have divided the organisation "vertically" so that hierarchies of operatives, supervisors, managers and executive directors have developed. (p. 99)

The increasing dynamism of the commercial world, brought about in large part by the spread of the gigantic (Heidegger, 1977) through the action of managerial discourse, necessitated a refining of managerialism. Predicated upon weaknesses identified through examination of its diffusion, the "congenitally failing" (Miller and O'Leary, 1993) practices of management and their associated discursive orderings of representations had to be reworked to enable their future instantiation in (viable) organisations. Managerialism sought to transform itself in order to ensure its survival. In the next section we examine the process and outcome of this transformation.

A New Commercial Agenda?

Although consolidation of the New Commercial Agenda (Munro and Hatherly, forthcoming; see also Kanter, 1989, on "The New Managerial Work") primarily occurred during the nineteen-eighties (Burrows et al, 1992; Whittaker, 1992; Reed, 1991; Ezzamel et al, 1992; 1993), signs of its emergence were apparent from the early nineteen-sixties (see Lash and Urry, 1987). To take yet another largely arbitrary starting point, examination of the work of Burns and Stalker (1961; 1966; see also Burns, 1958) provides us with a useful way in to this emergent discursive field and its break with past wisdom.

> Study of the practice of a number of firms suggested that there were two fundamentally different procedures followed by managements. One, 'mechanistic', was appropriate to stable conditions; the other, 'organic' to conditions of change. (Burns, 1958, p. 1)

The emergence and diffusion of discourse surrounding this latter management "procedure" are the main concerns of this chapter. Burns and Stalker's work may be seen as a source of both continuity and change with regard to the previous managerial discourse it sought to reproduce and redirect. It builds upon many of the understandings embodied in prior approaches (as well as the emerging discourse of the "Tavistock" school, see, for example, Hill and Trist, 1962; Emery, 1969) but also uses the "inadequacies" of these former approaches as grounds for its own production and dispersal, although Burns and Stalker are at pains to point out that their descriptions (prescriptions) of managerial activity are to be seen as a set of responses to a particular view of the organisation's environment.

> We have endeavoured to stress the appropriateness of each system to its own specific set of conditions. Equally, we desire to avoid the suggestion that either system is superior under all circumstances to the other. In particular, nothing in our experience justifies the assumption that mechanistic systems should be superseded by organic in conditions of stability. (Burns and Stalker, 1966, p. 125) [3]

Despite such caveats, the <u>ouvre</u> required for the production of a discursive rendering of "organic" management is primarily the "failure" of "mechanistic" management. In certain situations mechanistic management is seen to be part (the main part) of the problem. For despite the insistence on the specificity of the two forms of management and more importantly, the environmental specifics of their applicability, one gets a sense throughout the text that a changing environment is set to become ever more likely and ubiquitous. Such a shift is seen to necessitate "organic" management and technology (rendered as technical change) plays an important driving role in this respect.

> When novelty and unfamiliarity in both market situation and technical information become the accepted order of things, a fundamentally different kind of management system becomes appropriate from that which applies to a relatively stable commercial and technical environment. (Burns, 1966, p. vii)

> Organic systems are those which are best adapted to conditions of change. By common consent, such conditions are at present affecting a widening sector of industrial and occupational life. (Burns and Stalker, 1966, p. 11)

The sense of "self fulfilling prophesy" (Meyer and Rowan, 1977; Weick, 1977; 1979) surrounding Burns and Stalker's text is not entirely lost on the authors, although many of those that have followed in a similar tradition seem far less reflective.

> Technical progress and organizational development are aspects of one and the same trend in human affairs; and the persons who work to make these processes actual are also their victims. (ibid., p. 19)

Through a heroisation of the market and its supposedly manifest superiority as an optimal invisible hand for the purposes of (rational) resource allocation, competition and dynamism are taken as given (see also, Peters, 1992). An acceleration of "technical" [4] and "commercial" change is both a condition and consequence of organic management. An intensification and acceleration of Schumpeter's (1939;

1951) "creative gales of destruction" is seen to necessitate organisational responses that seek to add to the swirling winds that brought them into being. Representation of the "chaos" of the market and the dynamism of technology inside the organisation is seen to be the only realistic response (Peters, 1989; 1992).

> [T]he effective organization of industrial resources, even when considered in its rational aspects alone, does not approximate to one ideal type of management system, but alters in important respects in conformity with change in extrinsic factors. These extrinsic factors are all, in our view, identifiable as different rates of technical or market change. By change we mean the appearance of novelties: i.e., new scientific discoveries or technical inventions, and requirements for products of a kind not previously available or demanded. (Burns and Stalker, 1966, p. 96)

But one organisation's "extrinsic" factors are brought into being by the recursive action of its own and other organisations' <u>intrinsic</u> factors. Such a situation results in something analogous to a pack of dogs chasing their own and each others' tails. Actions seen as rational by individual organisations are made so by the similar actions of others. Notions derived from "Game Theory" provide us with some purchase here. As Axelrod (1984; see also Axelrod and Hamilton, 1981) demonstrates, individual (or organisational) self interest is a (collectively) stable evolutionary strategy even if the sum of its actions is not ideal for the community as a whole (see also, Barnes, 1990, on the "free-rider problem"). A competitive strategy is seen to be particularly well adapted to changing conditions, a relatively stable environment being seen to be necessary for the emergence of co-operation between entities. And the environment as rendered in the new commercial agenda is anything but stable.

Thus we can see that the discourse surrounding "organic" management or the new commercial agenda is both a condition and consequence of its own dispersal. "Giants" (Kanter, 1990) are made nimble through its actions and this nimbleness is required by the widespread adoption of nimbleness throughout the economy. Nowhere in this emergent discourse is this tendency more pronounced than in its treatment of information and communication technologies and information systems. The increasing rate of change, both "technological" and "market" based, brought about in large part by the prior diffusion of dynamic information and communication systems and technologies, is seen to necessitate the adoption of similar artefacts by any organisation that hopes to "compete" in such an environment. The adoption of (appropriate) managerial technologies is seen to be both rational and inevitable.

Managerial discourse and the rationalities they represent inform the translation of sociotechnical networks, but as the term translation suggests, they do not <u>determine</u> their specific forms (Rose and Miller, 1992; Miller and O'Leary, 1993). Rather, the technologies and..

> "Programmes of government" of the enterprise are.. "translations" between the "morals, epistemologies and idioms" of those rationalities and the practicalities of management or government of a particular problem space. Translations establish "..a mutuality between what is desirable and what can be made possible through the calculated activities of [managerial] forces" (Rose and Miller, 1992). (Lilley, 1993, p. 182)

In the following section we examine what it is that is distinctive about "organic" management before we turn to consider its role in translation. What enables and indeed "necessitates" the production and perpetuation of nimbleness and dynamism?

Organic Management: The Difference of the New Commercial Agenda

Burns and Stalker's (1966) check-list for the "organic" form admirably covers our objective: that is, to demonstrate the "difference" of the new commercial agenda. This is largely because it is described in terms of its distinctiveness from the "mechanistic" approach. Thus it seems appropriate to quote their delineation of the form at length.

> The organic form is appropriate to changing conditions, which give rise constantly to fresh problems and unforeseen requirements for action which cannot be broken down or distributed automatically arising from the functional roles defined within a hierarchic structure. It is characterised by:
>
> (a) the contributive nature of special knowledge and experience to the common task of the concern;
> (b) the "realistic" nature of the individual task, which is seen as set by the total situation of the concern;
> (c) the adjustment and continual re-definition of individual tasks through interaction with others;
> (d) the shedding of "responsibility" as a limited field of rights, obligations and methods. (Problems may not be posted upwards, downwards, or sideways as being someone's else's responsibility);
> (e) the spread of commitment to the concern beyond any technical definition;
> (f) a network structure of control, authority, and communication. The sanctions which apply to the individual's conduct in his working role derive more from presumed community of interest with the rest of the working organization in the survival and growth of the firm, and less from a contractual relationship between himself and a non-personal corporation, represented for him by an immediate supervisor;
> (g) omniscience no longer imputed to the head of the concern; knowledge about the technical or commercial nature of the here and now task may be located anywhere in the network; this location becoming the ad hoc centre of control authority and communication;
> (h) a lateral rather than a vertical direction of communication through the organization, communication between people of different rank, also, resembling consultation rather than command;
> (i) a content of communication which consists of information and advice rather than instructions and decisions;
> (j) commitment to the concern's tasks and to the "technological ethos" of material progress and expansion is more highly valued than loyalty and obedience;

(k) importance and prestige attach to affiliations and expertise valid in the industrial and technical and commercial milieux external to the firm. (ibid., p. 121 - 122)

More modern renderings of this approach in the discourse peddled by the new breed of management gurus, both practitioners and academics, (e.g. Ouchi, 1981; Peters and Waterman, 1982; Kanter, 1984; 1990; Crosby, 1984; Goldsmith and Clutterbuck, 1984; Waterman, 1988; Oakland, 1989; Piore and Sabel, 1984; Peters, 1988; 1989; 1992; Atkinson and Meager, 1986; Atkinson, 1990; Pascale, 1991) explicate these differences in terms of "empowerment", "flexibility", "quality", "culture", and "continuous improvement". These orientations are deemed to be necessary in order to compete successfully in markets that are increasingly global in scope. The literature emanating from such sources celebrates this sea change as it prescribes for its augmentation. It is almost invariably evangelical (Kerfoot and Knights, 1993), focusing only upon successes, and hence it effectively excludes doubt and self reflection upon the plausibility of its assumptions and the practical problems encountered in the implementation of its recipes. Indeed, the various guru recipes may themselves be viewed as so many products in a market for salvation (see, Hopfl, 1992, on the "Death of A Snake-Oil Salesman"). Such a standpoint serves to partially explain both the proliferation of these texts and the lack of reflection by their authors on the "side effects" of their prescriptions.

In its more modern forms, the new commercial agenda uses the exemplar of "modern legends" about Japanese and other Pacific Rim practices to demonstrate the inapplicability of traditional Western methods to the modern commercial world. However, although the terms may be different, and the conditions seen to necessitate their instantiation rendered slightly differently, there is a massive degree of convergence between the claims advanced in Burns and Stalker's work and those of the new commercial agenda of the nineteen-eighties. This convergence is perhaps most obvious when one compares Burns and Stalkers' delineation of the organic form (above) with Peters and Waterman's' (1982) eight attributes of "excellent, innovative companies".

The route to organisational success in the rapidly changing conditions rendered in this discourse is seen to be the production of appropriate systems of meanings that enable organisational participants to identify (more directly) with the purposes of their employing organisation (see also Robb's, 1993, "Possible Solutions to Growing Institutionalisation"). The new commercial agenda seeks to provide appropriate bodies for appropriate organisational forms that facilitate the generation of shareholder value. A key difference with prior practices is that this is to be achieved through identification with the products and "health" of the employing organisation (see Miller and O'Leary, 1993, on the "Politics of the Product") rather than through a more constraining commitment to what are seen to be abstract forms of hierarchical control. Such moves are supported by wider cultural shifts that seek to instantiate "neo-liberal" political ideals (Rose and Miller, 1992; Miller and O'Leary, 1993; Power, forthcoming).

Entities previously seen as "bads" (Beck, 1992a; 1992b; Power, forthcoming), such as "risks" and their reproduction, are reconciled with the production of "goods", i.e. wealth, through the creation of a moral order of representation in which successful managers are urged to "thrive on chaos" (Peters, 1990; see also, Peters, 1992) and "use conflict" (Pascale, 1991). "Requisite variety" within the organisation is required for the "evolution" of new organisational forms and practices. Mechanistic management's dream of capturing uncertainty through a proliferation of hierarchical relations is (partially) rejected in favour of a "network" of self organising technologies, bodies and understandings that are bound together through common identification with the products and profits of the employing organisation (see, also, Keenoy and Anthony, 1992).

The manager, as person, loses some of its significance as management, as shared understanding, takes over the organising role previously fulfilled by hierarchically positioned bodies. And, as we hope to demonstrate, embodiment of these understandings in appropriately defined managerial practices and technologies provides the missing glue.

Organic Management: The Sameness of the New Commercial Agenda

There are also significant continuities between the new and the old commercial agendas, reflecting an archaeology of control (Munro, forthcoming). Amongst the most important of these are the continuing problematization of individual commitment to the organisation and the continued importance of stratification and leadership in this problem's "solution".

The new commercial agenda is seen to be a cure for Western commercial ills made apparent by the emergence of a challenge to its economic hegemony from the Pacific Rim. One response to this challenge, urged by many contemporary management gurus, is the building of strong corporate cultures in which a kind of Confucian ethic is stimulated. However, as Ezzamel et al (1992, following Locke, 1990) note:

> there remains an underlying disjuncture between the collectivist ideas disseminated by the gurus of corporate culture and the deeply embedded Enlightenment beliefs in "individual freedom" and, more specifically, the operation of "free" labour markets and individual competitiveness (p. 30).

The old commercial agenda sought to engineer individual commitment to narrow, functional objectives which were supposedly integrated by the magic of hierarchy in order to generate a coherent organisation. Western individualism is uncritically accepted as given in both new and old agendas. Thus, although the new commercial agenda's solution differs, the problem remains the same. Indeed, the embededness of individual "freedom" and "competitiveness" in the West is such that the new agenda's solution only differs slightly from that offered by the previous orthodoxy. The route to collective organisational commitment is seen to be through appealing to individualism and notions of self appraisal and control. Thus, those whose skills are desired by organisations are induced and enabled to act "collectively" for the good of the organisation through hope of individual reward. Managers unable to adopt the orientations favoured by the new orthodoxy are easily jettisoned through invocation of a logic of "delayering" and "leanness", whilst those that remain are "promoted" in the remaining hierarchy (Ezzamel et al, 1992). Adoption of appropriate attitudes and behaviours is (temporarily) rewarded by continued employment and organisational advancement.

> Common ground is found by linking improved job security and career advancement with productivity and added value (ibid., p. 31)

Thus we see the need for the second continuity outlined above. Commitment to the organisation is seen to be deeper in organic forms but is also seen to depend on the perpetuation of stratification for its fruition. As Burns and Stalker (1966) note:

> while organic systems are not hierarchic in the same sense as are mechanistic, they remain stratified.. The lead in joint decisions is frequently taken by seniors, but it is an essential presumption of the organic system that the lead, i.e. "authority", is taken by whoever shows himself (sic.) most informed and capable, i.e., the "best authority".
>
> the area of commitment to the concern.. is far more extensive in organic than in mechanistic systems. Commitment, in fact, is expected to approach that of the professional scientist to his work, and frequently does. (p. 122)

Given the espoused commitment of employed individuals to organisational ends, accountability is heightened in the new commercial agenda (Munro and Hatherly, forthcoming). Whilst this emergent accountability is ostensibly lateral, with all those in the organisation accountable to each other for its continuing success,

> Conceptions of accountability are typically aligned vertically with reporting systems and are subordinate to a "surveillance" framing of control. (ibid., p. 1)

Thus organisational initiatives derived from the new commercial agenda frequently buttress stratification through an absorption of lateral accountability into extant systems of hierarchical accountability. Indeed, given the strength of belief in the "goodness" of individualism and competition it is difficult to see how this discourse could serve to do otherwise. The new commercial agenda still privileges bottom to top accountability, utilising lateral accountability to "improve" the efficiency of the surveillance system.

This leads us neatly into the third source of continuity between new and old agendas, the perseverance of the importance of leadership. As Burns and Stalker (1966) point out, in hierarchical systems the head of the organisation is seen to be omniscient through the marshalling and combination of knowledge that the hierarchical system provides. Pretensions of omniscience are absent in the new commercial agenda, but the role of the leader is no less vital. Leaders must not directly control the workforce, a combination of culture and represented markets and customers fulfil this need. Instead they must energise subordinates, empowering them as they seek to facilitate achievement of organisational objectives. Their activities must be culturally productive. This heroic role of "transforming" (Burns, 1978) leadership has a long history, extending at least as far back as the legends of the Vikings. Without an extended hierarchy, leaders take on a heightened mythical form of other worldliness. They are what other organisational participants must aspire to be. Their presence provides an instantiation of what the ideal organisational participant should be and hence fulfils an important role in the socialisation of bodies that approximate to that ideal (see also, Dugdale and Jones, 1993). Leaders must "walk the talk" as they act as exemplars of appropriate behaviour in the "new" organisation. To quote Burns and Stalker (1966, p. 211) once again:

> The head of the concern stands for the concern and its relative successes - he (sic.) symbolizes or personifies it. The management of the concern is also a career system, and the man standing on the topmost rung has to serve as a showcase for the characteristics which must be attributed to the person who is by definition the most successful.

Or as Peters and Waterman (1982) put it, in terms that could have been made for a discursive account of the new commercial agenda:

> The role of the leader.. is one of orchestrator and labeller: taking what can be gotten in the way of action and shaping it - generally after the fact - into lasting commitment to a new strategic direction. In short, he makes meanings. (p. 75)

In the delayered hierarchies of the new commercial agenda, a new form of leadership creates meanings to restore the coherence that hierarchy sought to instantiate but eventually destabilised. A large cadre of functionally defined managers is rendered unnecessary as managerial understandings are inculcated throughout the organisation. There is little need for management of others when discourse and discursive practices and technologies, coupled with the existence of an exemplary elite can engineer self management throughout the new organisation. For, despite the rhetoric and practices of "delayering", indeed perhaps because of them, more and more organisational roles are prescribed as professional/managerial. The "death of the middle manager" (Leavitt and Whistler, 1958; Drucker, 1988) signals the birth of a more ubiquitous but more invisible managerialism - the "responsible autonomy" (Friedman, 1977) of a self organising population of self managing individuals.

Critique and the New Commercial Agenda

Before examining how the terms of the new commercial agenda function in the translation processes of sociotechnical transformation, we briefly consider the role of critique in, and of, that agenda.

At one level critique is essential for the (re)production of the form of managerialism that the new commercial agenda represents. As Miller and O'Leary demonstrate (1993; see also, Rose and Miller, 1992; Lilley, 1993; Thompson, 1986; 1989), managerial activity, or more generally governmental activity, is "congenitally failing".

> Managerial expertise, and the government of the enterprise more generally, is a congenitally "failing" activity to the extent that a succession of programmes is the norm rather than the exception. (Miller and O'Leary, 1993).

As we have already noted, the ouvre required for the emergence of the new commercial agenda was the representation of failures of older forms of managerialism. In this respect, management may be seen as an archetypal "problematizing activity" (ibid.; Rose and Miller, 1992). The raison d'etre and obligations of management derive from the specification of problems to be addressed and very few "problem spaces" have retained immunity from previous managerial initiatives. Thus, the discourses, practices and technologies of management are "bound to the constant identification of the difficulties and failures of [management]" (Rose and Miller, 1992).

Managers colonise the right to manage through the perpetuation of a particular "moral fiction" [5]. That is, they claim to "possess systematic effectiveness in controlling certain aspects of social reality" (MacIntyre, 1985) through their access to particular forms of esoteric expertise and representational resources. This expertise is deployed both to explicate the indispensability of management and to provide managers with a vehicle for self instantiation (Foucault, 1978).

The apparent absence of a "rational" justification for managerial expertise has had little effect on the proliferation, deployment and transformation of managerialism. Realisation of the inadequacies of practices of management does not seem to lead to critical reflection on the philosophical underpinnings of the expertise deployed therein. Rather, the ineffectiveness of management serves to produce more management purporting to open up those "other" issues that brought failure to the prior "solutions" of managerial intervention (see also Baudrillard, 1983, on dissimulating simulations such as "Disneyland" and "Watergate"). The identification of the failure of one form of management provides a justification for the implementation of another (Lilley, 1993). Additional evidence for this position is to be found in the shifting nature of the calls to change produced by prominent gurus such as Peters (Peters and Waterman, 1982; Peters, 1989; 1992).

However, at another, more fundamental level, the need for management is seen to "hold" (Latour, 1987). Management does not seem to many to be peddling a form of "moral fiction". Most of the managers (and probably most of the managed) seem to believe in the importance of some form of management, most of the time [6]. Despite the appearance of a number of devastating critiques of aspects of the new commercial agenda, both in terms of its theoretical coherence (e.g. Robbins, 1983; Ray, 1984; Soeters, 1986; Barney, 1986; Fitzgerald, 1988;

Dahler-Larsen, 1991; Pollert, 1987; 1991; Willmott, 1991) and in terms of the practicalities of its implementation (e.g. Knights and Willmott, 1987; Smith, 1990; Wilkinson et al, 1991; Kerfoot and Knights, 1993; Kunda, 1992; Van Maanen, 1992; Wilkinson et al, 1992; Sewell and Wilkinson, 1992) there seems to be no slow down in the diffusion of its themes. Indeed recent evidence (e.g. Ezzamel et al, 1992; 1993) suggests that an accelerating proliferation of the discourse and its associated practices and technologies is underway.

However, as Foucault insists, it is power, not "facts" about reality, that makes things "true". The power relations and effects associated with the discourse of the new commercial agenda are evidently greater than those associated with fundamental critiques of that discourse. The new commercial agenda is more widely diffused and creative of entities with access to far greater resources than are critiques of that agenda. The representations it mobilises enable significant actions and it derives further support and legitimation from wider "neo-liberal" political rationalities (Rose and Miller, 1992; Power, forthcoming) As we have noted, the power relations of this agenda produce "effects of truth" within a discourse that we may consider to be "neither true nor false" (Foucault, 1980, p. 118). It is the outcome of the struggle over power that arbitrates the truth.

> [T]ruth isn't the reward of free spirits, the child of protracted solitude, nor the privilege of those who have succeeded in liberating themselves. Truth is a thing of this world: it is produced only by virtue of multiple forms of constraint. (Foucault, 1980, p. 131)

Indeed it is the existence of resistant critiques of this discourse that serves to alert us to its power effects. However, on another level a number of these critiques, substantial and well argued as they are, perhaps miss the point as they indulge a desire to let the "truth" shine through. Keenoy and Anthony (1992) draw together many of the strands of the new commercial agenda under the rubric of "Human Resource Management". And as they point out the virility of this discourse does not reside in its truth or falsity (see also, Clarke, 1992, on the aspirational power of "ideal types"). Rather,..

> to understand the HRM phenomenon in Britain it is is necessary to treat it as a cultural construction comprised of a series of metaphors which constitute a "new reality". HRM reflects an attempt to redefine both the meaning of work and the way individual employees relate to their employers. (ibid., p. 234)

The new commercial agenda produces meaning and produces truth. It is not usefully judged in terms of its own truthfulness. It is associated with more potent relations and effects than competing critical discourses. As Margaret Thatcher so eloquently put it: "There Is No Alternative", at least not a viable one. Thus, as Keenoy and Anthony (1992) remind us:

> [T]he "empirical reality" that must be penetrated before we can come to a properly informed understanding of the nature of HRM is what might be called the internal logic of the histrionics of HRM. (ibid., p. 235)

Such a position sensitises us to the validity and usefulness of Foucauldian conceptions of discourse in our attempts to apprehend the new commercial agenda. We now go on to consider the role of this powerful agenda in the translation processes of sociotechnical transformation.

Enabling Sociotechnical Change: The Role of the New Commercial Agenda

Given the overall cultural project of re-engineering individual commitment to the organisation's objectives, two themes of the new commercial agenda may be said to exemplify the frontiers of the representational space constituted by the discourse of that agenda. These two themes are "quality" and "flexibility" and they reflect a (potentially) contradictory tension at the heart of this discourse [7]. There can be little doubt that they are indeed central to the agenda:

> Today's and tomorrow's winning hand is becoming increasingly clear - quality and flexibility. (Peters, 1988, p. 22)

Moreover, the terms themselves represent almost universal "goods" (Power, personal communication). It is difficult to argue with calls for increased flexibility or improved quality as it was, and indeed continues to be, difficult to argue with calls for increased "efficiency". Arguments made in their name can only be rebuffed through invocation of the inadequacy of means. As ends their appropriateness is given and through a re-presentational sleight of hand this serves to ensure the "givenness" of organisational objectives. Activities must be made more "flexible" or be more "quality conscious" to better serve organisational ends, since individual success is seen to depend on organisational success and organisational success depends on "flexibility" and the "continuous improvement of quality". "Goods" abound, who could argue with that?

The space for action delineated by the dual action of these terms is admirably broad. Both terms are endowed with considerable "interpretive flexibility" [8] (Pinch and Bijker, 1987). And as Munro (1991; 1993) drawing upon the insights offered by Cohen (1985; 1987) demonstrates:

> it is this very ambiguity of signs which affords their binding properties. (Munro, 1993, p. 21)

Thus the terms "flexibility" and "quality" may be seen to bind communities of actors without overly constraining their potential for (suitably) diverse action. The terms may suggest, and be used to legitimate, a wide range of actions without the resulting cacophony of action (necessarily) resulting in unintelligibility (Arthur, 1993). These aspects of two of the key representational elements of the new commercial agenda are essential for the furtherance of that agenda. The terms are "flexible" enough to allow a range of possible actions deemed to be appropriate to the achievement of organisational objectives. The flexibility of the terms enables the representation of a "rag bag" of practices as together constituting a strategic agenda (Knights and Morgan, 1991; Munro, 1991). The requisite space necessary for translation, the inherent need to deal with the particularities of diverse entities enrolled in specific networks, is thus provided within a discursive framework that simultaneously provides a representation of the overall activities of the organisation as "strategic".

We conclude this chapter by considering the particular importance of each of these two terms in the logics of the new commercial agenda.

The Importance of Flexibility and Quality in the New Commercial Agenda

As Rose and Miller (1992) and Miller and O'Leary (1993) admirably demonstrate, the new commercial agenda may be seen to be part and parcel of a wider politico-cultural shift towards "neo-liberalism". In the USA at least, this agenda has been translated into a "politics of the product" (ibid.) that seeks to ensure that all organisational activities contribute to the product and to the satisfaction of the customer. The "Governmental Society" described by Peter Miller may be seen to be partially synonymous with Power's (forthcoming) "Audit Society". It is to this latter text that we turn to conclude the arguments of this chapter.

"Audit" is granted a wide definition in Power's treatment and encompasses the ubiquitous notion of quality.

> audit functions as a norm or "rationality of government" in Rose and Miller's (1992) sense... Audit is a particular manner of <u>(re)presenting</u> administrative problems and their solutions. (ibid., p. 2)

Audit (along with "quality" initiatives such as BS5750) is seen to be the "control of control" (ibid.), hence the similarity with more generalised notions of "governmentality" (Foucault, 1991).

> Audits function at a temporal and often spatial distance from the organizational processes to which they are applied (ibid.).

The governmentality inherent in the "audit explosion" reveals the importance of flexibility and quality in the new commercial agenda. Flexibility is invoked in order to loosen up rules of precedence and hierarchy, whilst quality is invoked in order to tighten up rules and reassert (a transformed) control. Through such processes "neo-liberalism" is realised.

> On the one hand, centrifugal pressures for.. decentralisation and devolution of.. services represent an "enterprization" [flexibilisation?] of.. functions. On the other hand, centripetal pressures to retain control over newly autonomised services inform a new governmental rationality in which intervention can be accomplished by indirect means. Audit [or quality] is a decisive political technology (Rose and Miller, 1992) in which these mutually constitutive forces are reconciled and ensures that the displacement of organizational hierarchies by market structures is never complete; audit [or quality] is the shadow of hierarchy which serves the appearance of central control. (Power, forthcoming, p. 7)

In this sense audit and associated treatments of quality represent an archaeology of control (Munro, forthcoming) derived from the "old" commercial agenda and embedded within the new. This enables the simultaneous production, reconciliation and dissemination of "loose-tight" (Peters and Waterman, 1982) organisational properties. Freedom and control are mutually guaranteed and enrolled to act for the good of the organisation.

In the next few chapters we examine in detail, in the terms of organisational participants, the intertwinings of entities and the emergent new commercial agenda in the processes of translation involved in the sociotechnical transformation of BP Oil's refining network.

The first chapter of this section concerns events that preceded the introduction of a Refinery Information System (RIS) at Grangemouth Refinery. However, the "facts" about these events, as rendered in the accounts of organisational participants, were seen by those participants to have played an important formative role in the emergence of the notion of integrated refinery information systems and the subsequent instantiation of that notion in RIS at Grangemouth.

NOTES AND REFERENCES

1. At least in certain sectors of the economy.

2. It is important to note that Weber had severe reservations about the all encompassing "iron cage" that a totalising system of bureaucracies could produce.

3. It is interesting to note here that "mechanistic" management may merely be "organic" management in conditions that are seen to be stable. In stable conditions there may be no difference between organic and mechanistic forms (Robb, personal communication).

4. Note here how the technical in Burns and Stalker's account functions as an explanatory deus ex machina (see Law, 1991, p.8).

5. Note here how MacIntyre's notion of "moral fiction" takes us away from a discursive rendering of management and re-introduces elements of an understanding based upon Ideology.

6. As we have already noted, the distinction between manager and managed begins to blur with the emergence of explicit forms of self management under the auspices of the new commercial agenda.

7. For Pascale (1991) at least, the existence of such a tension may be seen as a positive virtue.

8. No pun intended! Although as will soon become apparent, we must frequently use the term "flexibility" ironically.

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CHAPTER FOUR

THE EMERGENCE OF BRITISH PETROLEUM'S REFINERY BASED INFORMATION SYSTEMS

Introduction

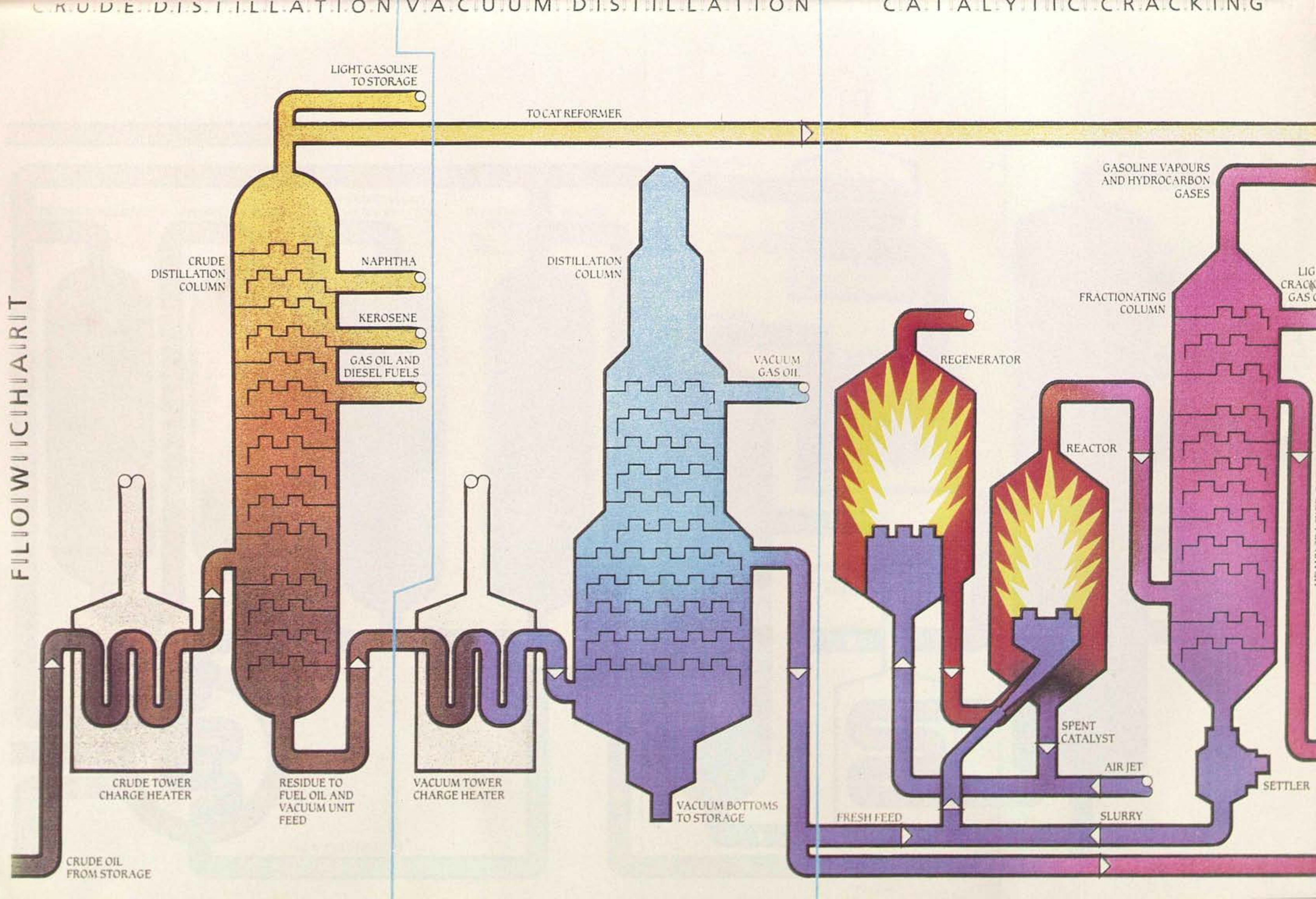
During the late nineteen eighties BP embarked upon a programme of Refinery Information System (RIS) implementations at its major refineries throughout the world. This chapter seeks to start to provide a context for the consideration of one such implementation that occurred at BP's Grangemouth Refinery in Scotland. An in depth case study of the Grangemouth implementation was undertaken by the researcher during 1990/1991. The material presented here concerns events that preceded the implementation of the Grangemouth system. This material is derived primarily from interviews with individuals involved in the Grangemouth implementation, both at the refinery and elsewhere within the BP Group. These organisational participants have attempted to identify the origins of the Grangemouth system as well as the factors affecting its final shape. Thus the following is an historical account of the development of the RIS concept within the BP Group. The researcher has attempted to describe the interaction of the pertinent factors identified and thus to provide a history of the development process.

Organising Oil Refining

An oil refinery transforms crude oil into products. Crude oil is a mixture of many hydrocarbons and refining involves the separation of the crude into its constituent fractions. Some of these fractions are subjected to processes designed to alter the molecular structure of the oil through chemical reactions. This is undertaken to transform plentiful low value substances into scarcer and more valuable substances. Finally, the various fractions and substances so produced are blended together, often with some additives, to produce the saleable products.

For the majority of its short history, the oil industry has been organised by a relatively small number of vertically integrated multinational companies. Since Rockefeller and his four associates established the Standard Oil Company in 1870 [1] the name of the game has been "integration". Rockefeller sought to combat the "'waste' of unbridled competition" [1] through economies of scale and scope, by combining and collecting the activities required by the oil industry under the roof of one company. Any companies attempting to attack Standard's monopoly position had to attack on all fronts. Thus the small number of major companies that were formed from the enforced break up of Standard Oil Trust and the few companies that challenged them followed the logic of integration.

The Anglo-Persian Oil Company, later to become BP was no exception. To avoid obliteration at the hands of Standard Oil, its successors, and the other emerging major companies, Anglo-Persian became an integrated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KEROSENE
GAS OIL AND DIESEL FUELS
DISTILLATION COLUMN
VACUUM GAS OIL
GASOLINE VAPOURS AND HYDROCARBON GASES
FRACTIONATING COLUMN
REGENERATOR
REACTOR
SPENT CATALYST
AIR JET
SETTLER
SLURRY
FRESH FEED
CRUDE TOWER CHARGE HEATER
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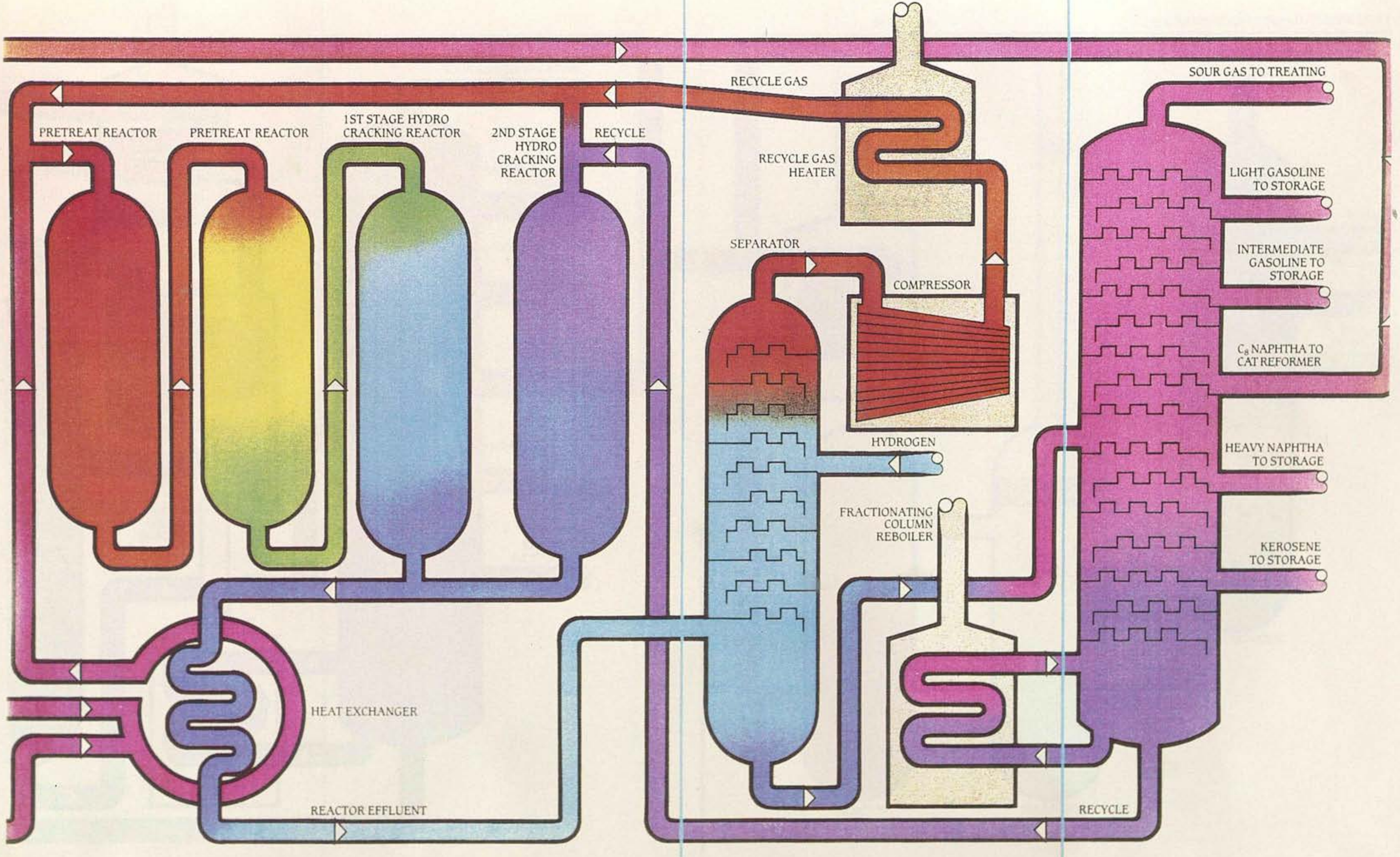

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PRETREAT REACTOR
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COMPRESSOR
HYDROGEN
FRACTIONATING COLUMN REBOILER
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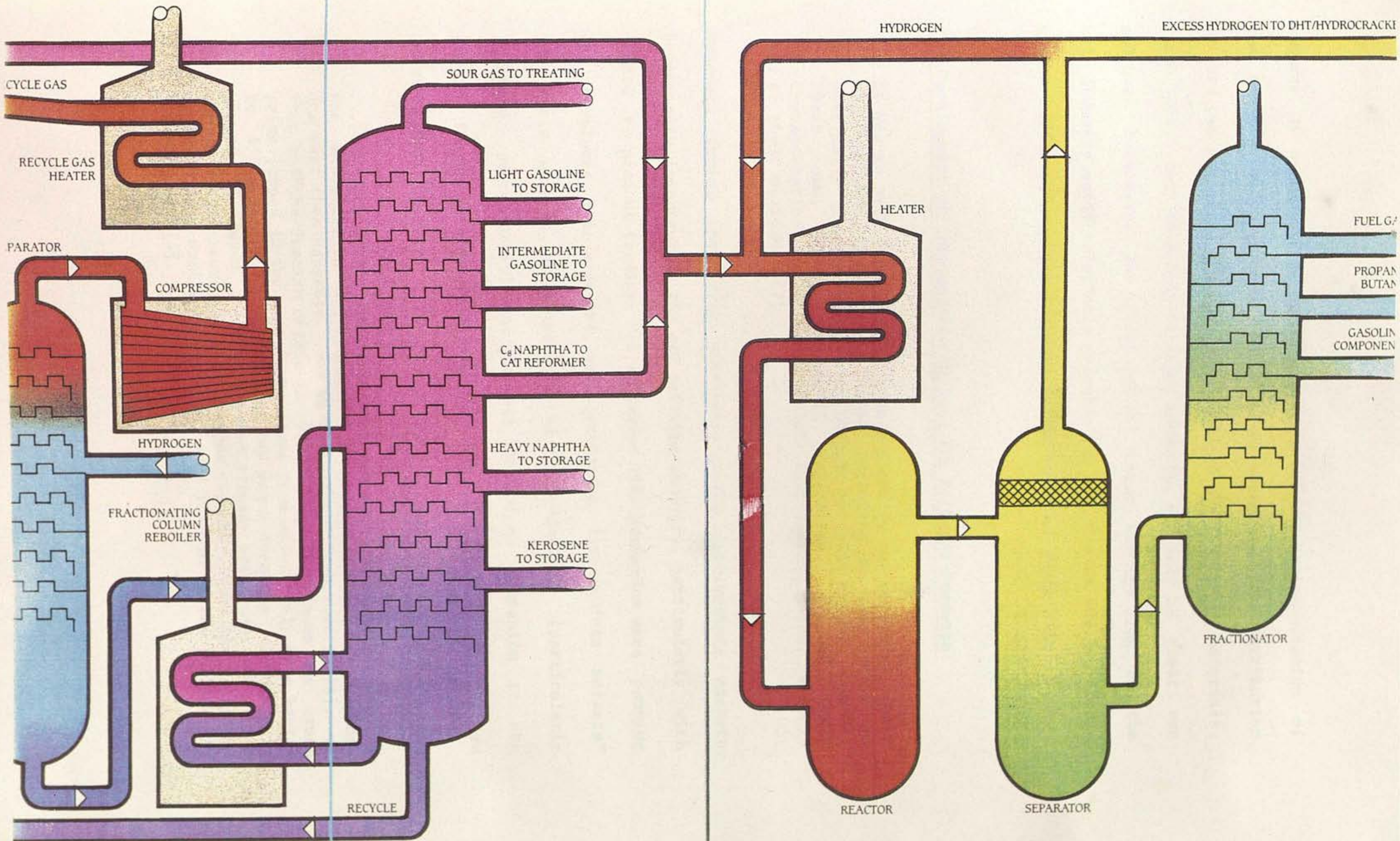
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company. It controlled exploration for its own oil, transportation of its own oil, refining of its own oil, and marketing and distribution of its own products. Oil companies produced their own raw materials, crude oil, they sold only finished products, and only to their own end-user consumers. The integrated oil company was the King of the oil industry until relatively recently but all of that was to change with a sudden and massive increase in the price of crude oil.

The Development of Intermediate Markets for Refinery Products

> If you go back far enough in time you get to the situation where oil companies, including in Europe, including BP, were acting as vertically integrated. So they brought in their crude, probably their own, through to their refineries, through their transportation means, through their distribution means, through to their customers [2].

However, during the early nineteen-eighties intermediate markets became more important to the oil refining industry, particularly with regard to product trading. "[R]efineries like Rotterdam were pumping out surpluses into a market, were generating intermediate markets" [2]. This was "...a consequence of overcapacity, [particularly European overcapacity] and [it was] the wish of companies to use assets in an overcapacity area that actually generated the third party market" [2].

> ...there was a vast expansion in crude oil processing capacity in the seventies in anticipation of a rapid growth in oil demand. Now what then happened...was we had...Yom Kippur...in 197[3], we then had the Iranian crisis in 1978/79...[and] because the crude price jumped in two very large steps from effectively $3 a barrel to $30 a barrel...what you then had was a dramatic slowdown in growth of demand. The capacity had already been built and hence people found themselves with surplus capacity. What they then had to do if they wanted to move the crude through it was get rid of the products [3].

> ...the overriding push was that you have all these fixed costs associated with refineries and you need to keep the throughputs up in order to spread those fixed costs around. You've got marginal economics to play and if you make a dollar a barrel in terms of producing an extra amount of refinery product and you can sell it then at least you've got that dollar a barrel. The fact that your total fixed costs might've been two dollars a barrel or more still meant that you were getting a contribution to fixed costs, and that always pushed the economics of throughput up beyond your markets [2].

Overcapacity in the refining sector was not the sole cause of the development of intermediate markets. There were also "Independents coming in looking to see if they [could] play blending games, moving the stock games" [3] The large volume of business and the increasing number of players involved were important factors.

> Inevitably when you have a large volume of business...you've got a lot of potential for people to come in and do their own bit, and the minute you've got a number of players then you have a vibrant market. [It's] no different from Covent Garden fruit and veg really,...the reason that's a vibrant market is that there's a large volume and there's a number of people that are involved for various purposes [3].

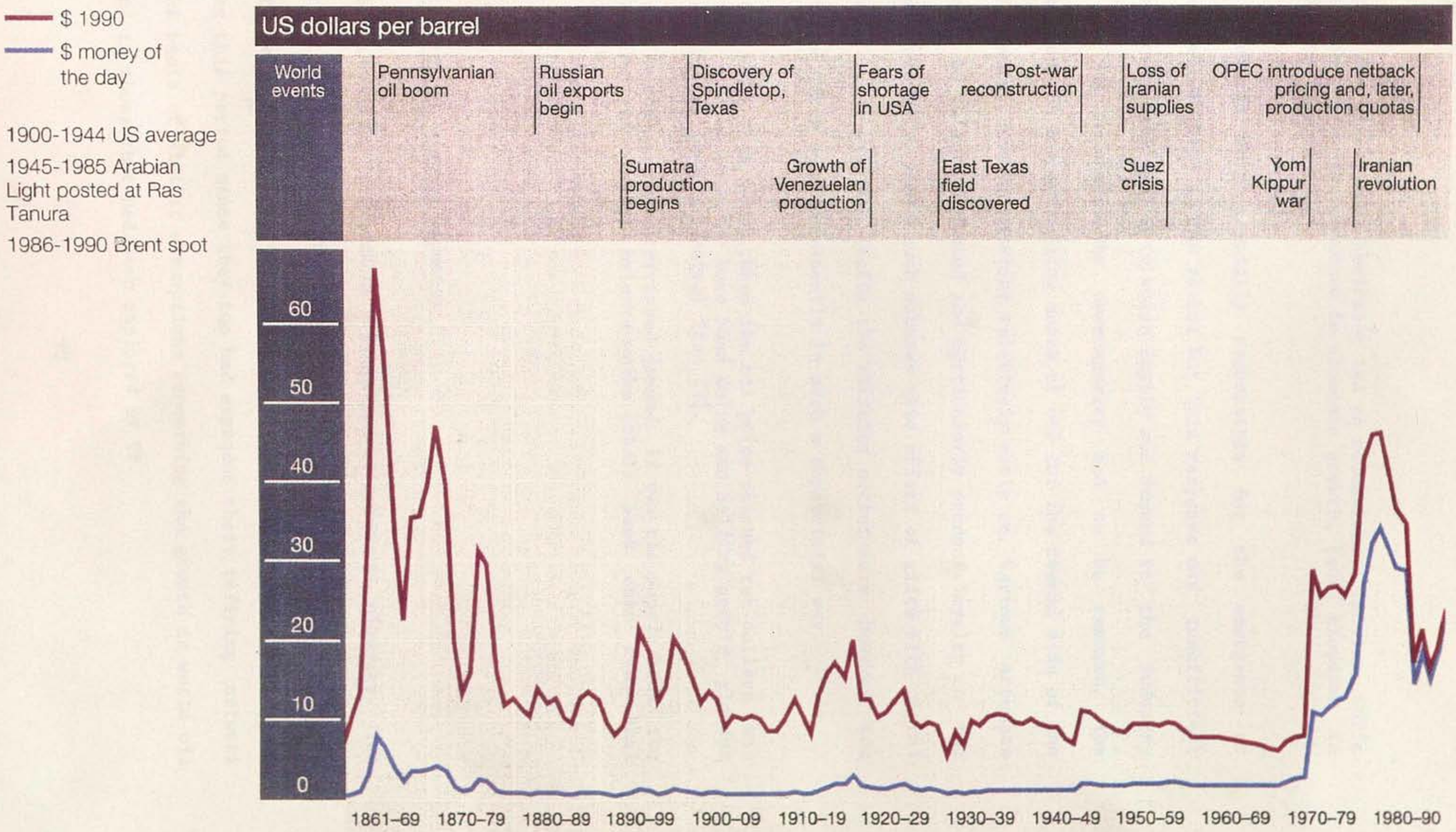
> Then the need came as to how BP was going to play in those intermediate markets and start to sell to third parties [2].

> ...you...had to control it because for the first time you had a third party interface coming into it. If it was internal there was no sale, you just moved the oil. Whereas what was happening is that we were making sales by barge to third parties. We had to invoice them, we had to control them, had to take orders, and all of a sudden there was a whole new commercial scene to manage [2].

Further Implications of European Overcapacity

As we noted in the previous section, the refining sector of the oil industry was confronted by problems of overcapacity in the early nineteen-eighties as a consequence of assumptions concerning the world growth of energy demand that were overturned by events in the nineteen-seventies.

CRUDE OIL PRICES SINCE 1861



> The two price jumps basically led to recessions, falling GDP's across the world, slowdown in economic growth, [and] slowdown in demand for oil [3].

These problems were partially responsible for the emergence of intermediate markets in the sector but this response was insufficient to ameliorate the extent to which supply and demand in the industry were out of balance. The overcapacity had to be removed. The implications of the spiralling costs of oil for the demand side of the equation were becoming apparent relatively early on. Various attempts were made to encourage demand and particularly product loyalty on the part of consumers. Among such schemes were offers of gifts with petrol purchases. The problems facing the refining sector were however too deep to be dealt with permanently in such a superficial way.

> Certainly the joke...when the oil price reached ten dollars was that what we ought to have been doing was selling people glasses and giving them the petrol free [3].

> Supply completely outstripped demand. If you tie supply back the supply and demand balance works itself back onto even keel terms [3].

The Removal of Surplus Capacity

Supply had to be tied back by a programme of refinery closures. The majority of these closures occurred during the nineteen eighties. Other refiners in Europe were also cutting back on their capacity during this period since they too had expanded their refining network on the basis of similar assumptions concerning the growth in world oil demand to those that had been employed by BP.

> ...quite a number of refineries [had to be] shut down because people saw that if you continued with the capacity that you had there was no way that there was any long term payback.. in the long term you weren't even going to recover your variable costs [3].

However, decisions concerning whether or not to shut down refineries are far from straightforward. The main parameters which are used to guide the decision making are not stable and there is a great deal of uncertainty to contend with, particularly with regard to the oil price. Getting the desired capacity was a very gradual process.

> Well, you run it for as long as it makes some kind of contribution to the fixed costs and even when it doesn't...you can shut all the units down but you don't close the whole site down. Hopeless PR, but also the margins are volatile themselves and...up until 1987 the margins bounced around a zero contribution but if you managed it properly you could at least do something [3].

As the previous quote suggests, supply costs and product revenues were not the only important factors when considering the extent and timing of these closures. Closures of refineries were seen to be one-way decisions. A closure decision was final and the company was unlikely to try to reopen a closed site. Public reaction to the consequences to the local economies of refinery shutdowns were also important.

> There was a lag in this because when you shut down a major employment centre, quite often in distressed areas of the country, for example in Llandarcy where it's a halfway decision, it's a difficult decision to take and there is often a length of time before the timing allows you to do it as cleanly as you would like. We're probably five years behind the time that commercially we would have liked to have changed from defensive to progressive investment [4].

Organisational Changes in the Early Eighties

The dramatic rise in crude oil prices precipitated by events in the middle east during the nineteen seventies did not have a uniformly negative effect on the corporation's ability to generate profits. As we noted, BP was a highly integrated company and the disintegration that occurred during the eighties was only in terms of trading relationships. The constituent activities of the organisation remained. Thus the BP group still has very considerable interests in exploration and production of crude oil and the organisation as a whole may have derived a net benefit from the rising price of oil. However, the refining and marketing sectors of the business certainly suffered as a result of the price changes.

Changes were made in the organisational structure of the BP group during the early eighties. Following a three year study of the group's internal organisation these changes, announced in December 1980, finally took effect in March 1981 [5].

> In the central group organisation most activities have been devolved into four principal Businesses (oil supply, refining and marketing; oil and gas exploration and production; chemicals; minerals), four smaller Businesses (gas; coal; nutrition; detergents), and BP Ventures [6].

The new structure was introduced to take "...account of the increasing diversity of the group's world-wide operations, [to allow] for greater devolution in decision-making, and [to establish] a basis for further evolution in the 1980's" [6]. The four principal Businesses were to be known as BP Oil International; BP Exploration; BP Chemicals International; and BP Minerals International [5].

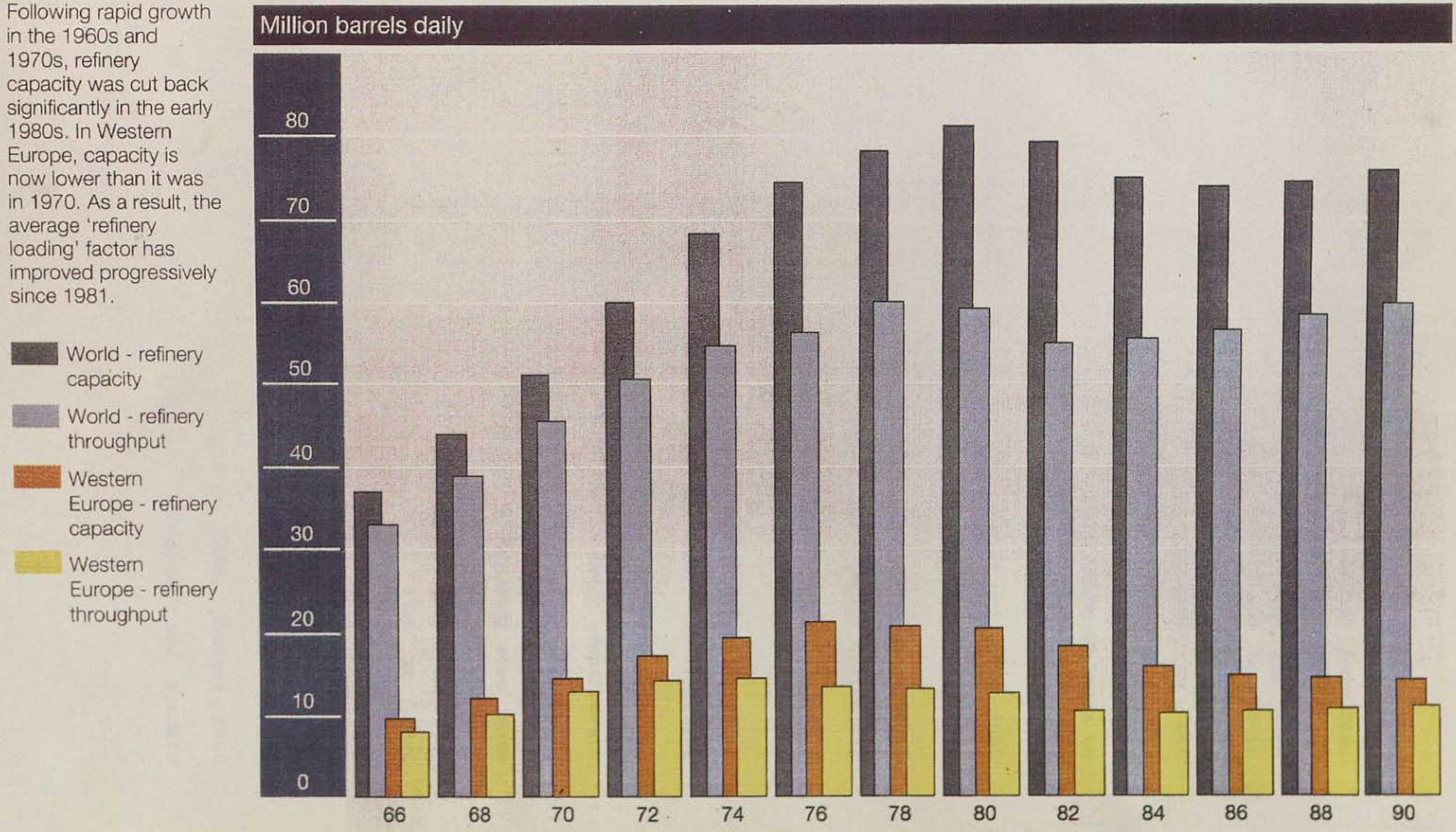
> Before that we were very much a unified company. We thought that concealed in a way where we were good and where we were bad. It was much better to be more transparent and much better to be more devolved and then businesses could be judged on their own terms, with their own competitors, and not have them concealed by the overall BP [7].

Revealed Performance and Refinery Closures

In November 1981 a new chairman, Peter Walters who started his BP career in 1954, took control of the group, and for the first two years of his stewardship the financial performance of the newly formed BP Oil International was considered unsatisfactory, with substantial losses being made in refining and marketing, particularly in Europe [8]. At the time of the formation of BPOI in March 1981, there was some 40% surplus in crude oil distillation capacity in Europe [8]. By early 1984 33% of the company's refining capacity had been closed [9], with the majority of these closures occurring in North West Europe. With a small revival in world oil demand and the removal of some overcapacity in the refining sector, \$125 million in refining and marketing losses in 1982 became \$297 million in profits in 1983 [9]. (although in 1984 BPOI's profits dropped to just over half of the previous years total [10]). Further action to reduce overcapacity in Europe continued through 1984 and a series of new rationalisation measures were announced in January 1985. Much of BP Oil's European refining capacity was removed. On completion of these changes BPOI had reduced its European crude oil distillation capacity to 65 million tonnes per annum, a reduction from the beginning of 1981 of 43 million tonnes per annum. In 1988 BPOI had five major refineries in Europe compared with sixteen in 1981 [11]. The 1988 Director's report concluded that...

REFINERY CAPACITIES AND THROUGHPUTS

Following rapid growth in the 1960s and 1970s, refinery capacity was cut back significantly in the early 1980s. In Western Europe, capacity is now lower than it was in 1970. As a result, the average 'refinery loading' factor has improved progressively since 1981.



> The volatile trading environment has vindicated our highly flexible policy towards crude oil and products supplies, especially in Europe. After trading around one million barrels of products a day, we sell more than we refine. However, our refining throughput is now more in balance with our core marketing demand. We tailor the mix of own-refined and bought-in products to take advantage of market fluctuations. We are one of the world's leading bulk traders of crude oil and products, an activity that contributes directly and indirectly to our downstream [refining and marketing] performance [11].

One can see the early to mid-eighties as a period in which BP began to vertically disintegrate and take on a more commercial focus, particularly within the newly created businesses that were once just elements of a centralised group. The relative autonomy devolved to BP Oil International by the BP Group Corporate Centre, partially replaced centralised control with a commercial orientation. The new businesses were responsible for their own performance in the market.

The relationships between Manufacturing and Supply within the newly formed BP Oil International were fundamentally altered. The refining or manufacturing side of the business no longer simply responded to BP's customers needs filtered through the central supply department. Refinery products could be traded entrepreneurially and predictability of supply in an increasing complex environment was becoming ever more critical. It was becoming more and more important for the activities of refineries to be made if not perfectly visible, then at least predictable to elements of the BP Oil organisation that were remote from the refineries. They needed more information on manufacturing in order to deal with the increasing complexity arising from huge changes in the nature of the distribution and supply side, changes that resulted from the increased importance of marketing and product exchanges with other oil companies.

The Increasing Importance of Product Exchanges

As we noted previously, until the early eighties oil companies were largely vertically integrated. This situation applied to BP but there were some important differences between BP and the other majors.

> Some of the American companies, the Texacos, the Essos, were very integrated and would rely...a lot on their own system. BP, partially as a function of leaving Kuwait, Nigeria, [and] Iran, had to get involved in other forms of getting crude oil for its refineries. It then also went through a series of refinery closures [in North West Europe and] then...found that what it did have was...a lot of capacity let's say in the Rotterdam refinery, but it was deficit elsewhere as a result of those closures. Now all those events mean that you've got to go out looking to somebody else to buy the stuff...We had to get hold of crude from various other sources [and] the shutting of refiner[ies] then means that...you've now got to start trading products, to start sourcing them from different places [3].

BP moved from a situation where occasional crude and product transfers occurred, known as "managing imbalances" [3] to one in which the co-ordination of distribution and supply through links with other players became core to the business. BP Oil UK's Supply Division has to ensure...

> ...that we supply our markets profitably within the procedural constraints under which we have to operate, and the main function through which we achieve that is exchanges [12].

Grangemouth is now BP's only crude oil refinery in the United Kingdom. Ten years ago BP operated four refineries in the U.K. at Grangemouth, Kent, Llandarcy, and a small one in Belfast. This surplus capacity meant that little exchange of product with other oil companies was required. However, with the partial closure of Llandarcy and complete closure at Kent and Belfast, BP found itself with a market based almost entirely in the South of England whilst its refining operations were concentrated in Scotland. There has been a change in emphasis away from a primary concern with refinery co-ordination towards consideration of marketing and exchange issues, or "Exchanges and Modal Planning" [13]. Exchanges are made with other oil companies to ensure adequate supply all over the country. Oil companies, including BP, are understandably reticent on the subject of product exchanges. The arrangements have a tendency to look like the sort of cartelisation reviled by the press since virtually the inception of the oil industry. BP Oil even provided its employees with a ready made justification of these arrangements in its in house newspaper [14].

> Contrary to tabloid newspaper wisdom, it's not a cosy relationship between big oil companies designed for their benefit at the expense of the customer.
>
> But for the fuels exchange system, the cost of fuels would be higher than it is now, says Janet Hogben, manager of the Exchanges Section which is located at Hemel.
>
> "If every one had to supply their own product to all locations from their own refineries you would find companies would pull out of certain areas which would reduce competition.. There is no doubt therefore that exchanges are a force pulling prices down."
>
> These exchange deals enable BP and other companies to provide national coverage economically. BP operates with many oil companies in the UK which in turn have deals with one another. The Exchanges Section estimates there are 500 or so different elements to be renegotiated annually [14].

Thus, the nineteen eighties saw not only an unprecedented increase in the importance of marketing of refinery products but also, through the removal of overcapacity, an equally large increase in the importance of product exchanges. For example, BP Oil UK supplies approximately half of its customer demand through exchanges.

> ...about four million out of the eight million tonnes delivered to customers are provided through exchanges [12].

Rotterdam's Position in Relation to the Developing Markets

The emergence of this "commercial scene" and the need to manage refining activities in relation to an intermediate market were particularly marked at BP's Rotterdam refinery. The activity of the refinery was very closely linked to the activities of buyers and sellers on the Rotterdam spot market [15]. The spot market, as we noted, developed partially as a consequence of the defensive behaviour of oil companies in response to overcapacity in the refining sector [2]. The market that so developed is a logical market, not a physical one, with trading activities distributed throughout a number of centres in Europe [16] Thus, the Rotterdam spot market [17] is an independent commodities market with its own traders and sources of information. Its activities are made visible through Reuters' reporting of market indicators [16].

Thus although Rotterdam refinery had a relatively small local market, it was well placed to deal with North European trading on the spot market [15]. It would seem that Rotterdam refinery's geographical location in relation to North European trading routes, coupled with the emergence of an intermediate market for refinery products, and later supplies [2], placed it in a situation that presented significant commercial opportunities. However, the benefits of playing in an intermediate market did not come without costs. The main one of these costs being the consequent increase in the complexity of the oil management problem at refineries.

Implications of the Geographical Separation of Manufacturing and Supply

Refining represents only one side of the Manufacturing and Supply activities of an oil company. Refining, the production or manufacturing side, must be co-ordinated and managed to ensure that customer supply demands can be adequately met. The supply side of the Manufacturing and Supply Division of BP Oil seeks to ensure "...that we supply our markets profitably within the procedural constraints under which we have to operate" [12]. The supply function is concerned both with making sure that customers are supplied with refined products and also ensuring that refineries themselves have adequate feedstocks to produce the prescribed product mix to satisfy those customer needs. In short, each refinery's field of competence is almost entirely limited to the running of plant and the blending of components so produced. Decisions concerning the sources of raw materials, amounts of raw materials required, destinations of products, size of production, and product mix are the concern of the supply function. Today, these decisions are becoming more of a matter for negotiation between the refinery and the supply function, but during the early eighties this was not the case.

Historically, this supply co-ordination task had been carried out at the corporate centre in London. Whilst BP was acting as a "vertically integrated company" [2] dealing with it's end-customers directly, before the emergence of these intermediate markets, this arrangement did not seem to be problematic [18]. Thus, for Rotterdam refinery the manufacturing and supply functions were, and had always been, geographically separate. The two functions were approximately 200 miles apart [15]. The activities of those individuals concerned with commercial dealings in refinery products and supplies, who worked from the corporate centre in London had a considerable effect on Rotterdam refinery's activities. These effects were particularly pronounced at Rotterdam, as we noted, due to its proximity to an important trading area on the spot market, and thus the activities at the refinery were very closely linked to those of buyers and sellers on the spot market [15].

<u>An Information Systems Solution to the Separation Problem</u>

BP were reluctant to relinquish centralised control of their supply function, and thus a computerised system was developed in the early eighties to bridge the gap between Rotterdam's manufacturing and London's supply functions [4]. The refinery's proximity to, and dependence on, the market had created an acute management problem [15]. BP traders working within the supply function in London needed information on the refinery's stocks in order to allow them to play the market.

> ...theoretically you could sort out the Rotterdam control problem by transposing the commercial control across to the refinery. Now, in fact, what we chose to do as a company was not to do that but actually bridge the gap using technology [4].

Thus, the desire to maintain centralised commercial control led to the introduction of a distribution monitoring system, known as SIS, (Supply Information System [19]) to BP Oil's corporate centre at Britannic House in London in 1982/83 [20]. This was, in essence, a supply control information system at the London supply centre, "upstream" of refinery production.

> ...the refinery had a direct link into [the system], so it was actually run completely at the London end of things [20].

The supply division in London produced production requirements and "...then it was downloaded to the refinery, then production would handle it" [20]. Thus the SIS system provided a partial solution to the problem of controlling production in relation to the demands of an intermediate market. However, this increased ability to play the market that the system provided to the London supply division had some unpleasant side effects on the complexity of the refinery production management task. Tensions developed during the early eighties as the SIS system facilitated the traders ability to trade. The problems grew as immediate electronic trading became more important [15]. Rotterdam refinery's proximity to the spot market's main distribution route, coupled with the traders increased ability to trade resulted in the refinery using up to fifty different crude supplies a year. Each cargo of crude was throughput in approximately two to three days. Thus every two to three days the refinery had to respond to changes in its supply side, whilst at the other end output was extremely variable as it was market driven [15]. This resulted in BP Oil being unable to honour agreed deals from its own refinery manufacturing. Instead they were forced to buy stocks on the market to meet customer needs to which they were committed. The organisation was being forced to act as a "distressed" purchaser, leaving itself in a vulnerable position [15]. According to a refinery programming manager at BP Oil UK's Head Office in Hemel Hempstead,...

> ...the whole aim of this [the supply division co-ordination task] is to get advance information to avoid being in a distressed position (my emphasis) [12].

Traders trading on the spot market can commit the refinery to supply a customer up to approximately one month ahead of delivery. Thus the traders were dealing in terms of the future production capabilities, but they were basing their deals on current rather than future oriented information.

The Traders Use of Information

The notion of traders' increased ability to trade on the basis of the SIS information is a slightly simplified view of the situation. The traders are making "seat of the pants" decisions, and the last thing they want to be doing is ploughing through reams of screens. Moreover, much of the information available pertains to aspects of manufacturing and supply that lie outside their field of expertise.

> They don't have the background to understand what the information means. People who understand it best have already seen it. And they don't have the time [3].
>
> A lot of those traders are not engineers, they do not necessarily understand the refinery and they are not the people who are dictating how the refinery runs [3].

As the previous quote suggests, the traders are working within quite severe constraints set by the supply function.

> The supply people have to judge...what they think the correct levels of stock holding [are] and the most optimal manner of getting the right stocks into the right place [3].

> Supply people are essentially considering movement of stock and ensuring there is enough stock to go round all the terminals. The traders are...trying to balance that when there is a demand to buy in or sell out [and optimise the price paid or received] [3].

With advanced information systems...

> ...you do have a great deal more information [but] what it hopefully does is it allows the people who send the requests and are [talking to] the traders...to have greater confidence in what's going on so that the level of instruction they can give to the trader is more secure, is more accurate, and hence allows more opportunities [3].

> [SIS information] enhanced [the traders] understanding of what stocks were available but [they] never saw that information [directly]. It went to the [supply] operational function within the Head Office and they then presented the options to the traders [3].
> The Head Office then, and it's still the case,..dictated the plan for the refinery, decided what stock levels should be. They didn't decide what tank should be blended with what tank to make what, but they did decide what the demand levels were and what should be manufactured [3].

The task of deciding "what tank should be blended with what tank" was, and is, undertaken at the refinery by production schedulers. Since the early eighties BP Oil has been...

> ...creating little teams [grouped around particular products] of effectively a supply operations person, a trader,..a [refinery] scheduler, and somebody...in supply...who evaluates the value of [components and products to us]...because...they've all got part of the picture [3].

Decisions concerning the precise activities of BP Oil's manufacturing and supply operations emerge out of communications between these individuals. These decisions are not really systematised. The relationships are...

> ...loose because the decision is so complex no one person can hold it together...For each element of that decision making somebody's responsible so you've focused in there but what you say is that the whole needs the collaboration of a number of individuals [3].

These decisions are still made in the same way today, although the influence of the various stakeholders has changed over time. This may be seen as at least partially a result of changes in the information available to the different stakeholders involved.

The Importance of Refinery Based Information Systems

The supply function is not the only information filter for the traders, the refinery schedulers also fulfil such a function, considering the information available to them and utilising their expertise to inform the traders of its salient points "...and make part of their decision for them" [3].

> ...what [the refinery schedulers] have to do is dress the information in a manner which is most useful to [the traders]. [T]he scheduler is sitting there between the refinery and the trader and the supply operations people and thinking...with what I'm doing with this refinery what is the best way of making availabilities [3].
> [Availabilities here refers to both excess products that may be tradeable and opportunities for the absorption into the refinery system of feedstocks that may then be purchased by the traders at a "nice price"]

The "distressed purchasing" was seen as symptomatic of the poor quality and lack of (timely) availability of information, particularly to the refinery production planners and schedulers [15]. It is the schedulers and planners who carry out much of the on site oil management activities. Thus, a need was perceived for a system that would allow "managers at Rotterdam to manage their plant more effectively" [15]. In effect, the SIS system had enabled the London supply function to provide the traders with more opportunities. The refinery schedulers had derived some benefit from the system because "...it gave them greater awareness of exactly what they had in various tanks" [3]. But on balance the major benefits were derived by the London supply function. As we noted, the traders were not directly affected by the system, their improved information was provided by their contacts in the supply/scheduler/trader nexus. An asymmetry had developed leading to a bottleneck in BP's manufacturing and supply system. This bottleneck was at the refinery and it made the schedulers' production management task considerably more difficult.

Rotterdam Refinery

One of the European refinery analysts from BP Oil Europe's Manufacturing development group described Rotterdam's situation:

> Well it's an odd kind of refinery, coupled with the fact that it barge trades, so you know, you then have very small boardings which means there's a considerable scheduling problem. And because it's entrepreneurial it had to respond very quickly to the market whereas other refineries like RVI [in Bavaria, Southern Germany] for example, is land-locked and supplies a local market, Grangemouth is much the same, it's much more stable [20].

As we noted, during the early to mid-eighties these tensions were an increasing cause for concern. A refinery based RIS system was seen as providing the potential for a technological solution to the problem.

I think we were losing quite a lot of profits then. I wouldn't call it a crisis, that's sort of steeped in erm..., it was obviously the most prominent refinery that needed such a solution [20].

One member of the BDU team who was deeply involved in the Rotterdam RIS strategy study described his "personal view" of the situation as a "resonance" problem.

> You've got variability at both ends with the plant in the middle and switching the plant activities was a slow process. If you did attempt to change inputs and requirements quickly a great deal of turbulence developed within the plant processes. Thus the plant was very difficult to manage [15].
>
> ...management were being run by the plant rather than running the plant [15].

Another manager noted the inadequacy of the SIS system in terms of its inability to look forward. Traders on the spot market can be committing to deals up to a month ahead of delivery [3]:

> It wasn't enough just to have what stocks are currently tested in tanks [at the refinery] because what was actually important in terms of committing the business of the next day and the day afterwards, which is what the...traders were doing and had to do, is they had to have confidence in what was going to be produced (my emphasis). In other words they had to have confidence in a production plan. They didn't need so much to know the position now because they dealt in the future. They needed to know what the position was going to be tomorrow and the next day. Only then can you actually take control of the whole physical flow [4].
>
> ...when you make a sale you commit yourself to supply a customer in the future [21].
>
> ...working stock levels for refineries are very limited, therefore you cannot work on a replacement stock basis because the variability, or "noise" in requirements is greater than the stock balance. Hence the need to control the future [16].
>
> You could not handle the amount of barge volume that was taking place out of Rotterdam by hand. It was just, the co-ordination required, the speed of response, was not possible [2].

Thus, the production planning systems at Rotterdam were perceived to be a "bottleneck" that needed unblocking. The degree of variability in Rotterdam's production and supply profile was such that "...the monthly plan [produced by the London supply division] was largely redundant immediately, and thus the refinery required an enormous amount of on site [oil] management" [15].

The Emergence of the Rotterdam RIS System: Rotterdam in Crisis

A small project team was set up at Rotterdam by the corporate centre Manufacturing and Supply Business Development Unit (BDU) to try to address these issues. The aim was to examine the systems in place and attempt to develop them to allow the site management to regain control [15]. The team started off by asking the managers at Rotterdam what their principle objectives were within the refinery. The rather worrying answers they received, in the light of the new commercial opportunities emerging from the developing intermediate markets, were that their objectives were:

1. Jump for London
2. Minimise stocks
3. Minimise costs [15]

It would seem that the refinery management were faced with such an acute management problem that they simply did not have time to engage in consideration of the commercial implications of the emerging markets. The implications as far as they were concerned did not seem to move beyond an endlessly defensive battle with an expanding logistical nightmare.

The Rotterdam study team tried to supplant these objectives of a loss reduction based operation with the idea of profitable operation. They sought to expand the management focus from its current concern with reducing costs, that is raw materials and refining costs, to encompass consideration of the price obtainable for manufactured products. The refinery management were told by the project team that their principle objective should be profit maximisation [15]. BDU's had considerable influence within the organisation during the mid-eighties.

> The idea was that they would direct the strategy of those businesses [for which they were responsible] within BP Oil, but only the strategy. But over time, they grew to be sort of monsters, employed an awful lot of people and interfered frankly far too much in operational areas [7].

However, as far as the refinery management were concerned the complexity of their present task precluded much consideration of the profit and loss implications of their activities. Before the managers could direct the refinery's operations in a profit seeking manner, they had to regain control. And the study team sought to give them back that control through the creation of an "integrated oil management system" [21].

The inadequacies of the SIS supply to manufacturing link as a total solution to the problems of the emerging commercial scene demonstrated that the co-ordination problem could not be solved by merely making stock information on the refinery available to the remote supply division...

> ...and therefore at Rotterdam they evolved from accessing operational data which was then shared across the English channel through to jointly planning. Then this whole RIS thing of single planning and control of refinery activity and the scheduling timetable arose [4].

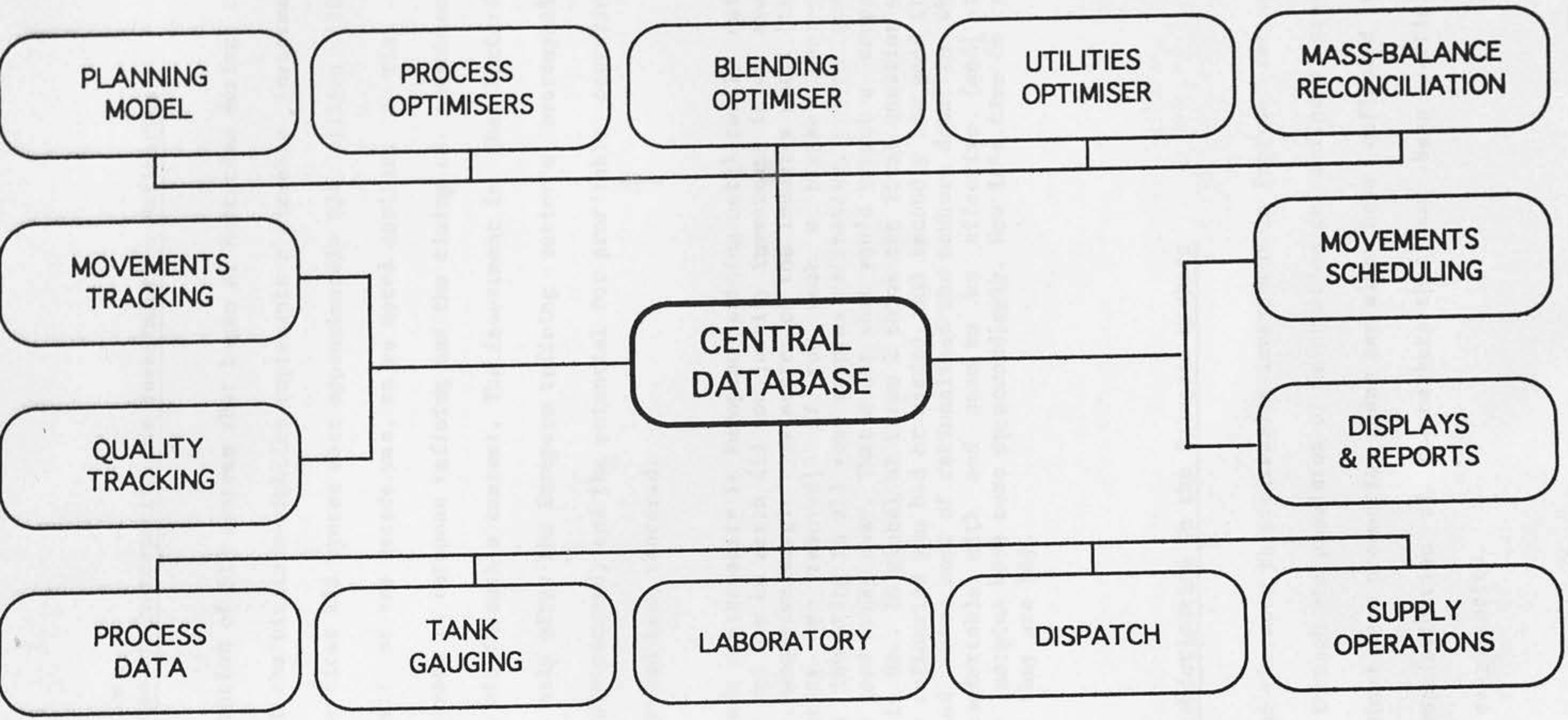
> The operations of the plant were set on one set of assumptions which would be changed more rapidly than you could re-plan the effects of those changes. And it's actually speeding the whole process up to that degree of coherence which attempts to put you in control [4].

Another manager who was involved in "implementing the commercial heart" of RIS and who was also involved in "the feasibility study for the Rotterdam system", had this to say:

> You can actually visualise a series of building blocks: process control; advance control; on-line optimisation [through the use of Linear Programming modelling techniques]; and RIS basically is dependent on those, and RIS sits above the whole framework of data capture basically. You need the infrastructure otherwise you can't support it. You've got to collect data, that's the key principle, and the second idea is that having got the data you just want to present that to management, or people who actually need the data to work with, that's one thing you can do with it. But what [the RIS] at Rotterdam tried to do, and subsequent RIS systems are trying to do, is actually how do you use the data to your advantage to generate a commercial edge over your competitors? And the idea is basically that you have the data, you have computers that can handle that data and manipulate the data for you, and that basically allows you to shift data from one application, modelling system, whatever, into another. So it's allowing you to <u>integrate the modelling systems</u> (my emphasis) [20].

The systems at Rotterdam seem to represent a two stage attempt to regain <u>effective</u> control of the manufacturing and supply function in the face of the new demands and opportunities presented by the emergence of intermediate markets. SIS was the first stage providing a link between Rotterdam and Britannic House. RIS was the second stage response to the realisation that current stock data alone was not enough to solve the manufacturing and supply co-ordination problem. It sought to fulfil the need for a coherent, wider, corporate production plan [4].

GENERIC OIL MANAGEMENT SYSTEM CONFIGURATION



The Consequences of Overcapacity for Investment in Refineries

The implementation of RIS systems that began at Rotterdam during the latter half of the nineteen-eighties represents a sizeable investment for BPOI. The first RIS system cost approximately $24 million [20]. The first half of the decade was, as we noted earlier, a time of significant losses in European refining and the timing of investments must be seen within such a context. The investment in the Rotterdam RIS occurred only after the European refining sector's overcapacity had been largely removed, and the potential for profitable operations in that sector had been restored.

> [T]here was overcapacity in European refining until really quite recently and how on earth did you justify investment in an over-capacity, negative margin type sector of the industry until [that overcapacity was removed]? If you took a blanket shot-gun approach investing in all your surplus refineries, you're going to throw good money away. That's not what you'd expect a company like BP to do.. In global BP terms I think the first question was how many refineries you had or needed, and secondly how good they were. And we've sort of rationalised the numbers down to what we're comfortable with and seem to be effective [and] the refinery margins have come up accordingly. Now it's time to see how good they are [4].

Increasing Sophistication in the European Markets

The timing of the move to progressive investment to improve refinery performance through the provision of information on refinery stocks and later short term production plans may also have reflected the developing sophistication of the markets that had been partially generated by overcapacity.

> In the development of most markets you go through steps of development.. In the case of a.. flexible spot market [the first step is] becoming aware of the numbers of players and all their interests and finding which people are the best ones to put it to. Now after a couple of years you've sort of done all that and you've got that bit of it well sussed. Now I think as far as BP was concerned ..that was fairly well sussed by.. about 1986, 87. What you then go on to is the next degree of finesse [and] in the spot markets people started looking a bit more closely at qualities, it's actually what qualities have we got. Let's not just sell to the spec., if we've got some quality giveaway let's see what we can do there. Now I think that's when some of the RIS information starts becoming more critical because you're not just selling a tank of gasoline, you're selling that tank of gasoline and it may be that that tank of gas oil's worth more than any other tank of gas oil but until you get the information you don't know. It's also starting to be a bit more cute on the stock levels, exactly what are the stock levels? So you're not just looking at the volume of the the market, you've now moved on to another level (emphasis in original) [3].

Once the organisation had got down to the number of refineries it "wanted" to run the issue of how they were run became far more important. The investment in RIS systems was difficult to justify in a situation in which supply completely outstripped demand. In such circumstances the marginal benefits to be derived from a RIS system were relatively insignificant. Organisational particpants did not underestimate the complexity of the "technology" involved in a RIS system and an effective design for such a system may have been virtually impossible to achieve in the early eighties. However, the absence of interest in the benefits derivable from RIS type systems and the defensive investment environment in the early eighties in the European refining sector, brought about by high crude prices and overcapacity, made a move to such systems unattractive, at least temporarily.

> [I]t comes back to that principle of ratcheting up your level of detail and RIS is taking you on to a [new] level of detail. Now really for some time in the late seventies and early eighties I don't think people were at that sort of level. I mean it was all

> about how much capacity you had before you could then sort that out and.. move on to the next step which is what's the best way to run it [3].

It is difficult to go for a sort of niche marketing strategy to sell a particular high spec. tank of product when the market is awash with a surplus of products. "You can [do it], but people's minds are elsewhere" [3]. The marginal economic benefits that RIS potentially provided were only practically achievable once the overcapacity in the European refining sector had been removed. In terms of the profitable operation of a refinery in a market where supply and demand are in some sense balanced..

> ..[k]ey parameters are actually plant availability and RIS operates at a level optimisation which is one level below that. In other words, the first thing that determines whether the refinery is effective or not is whether it can run the plant that it's supposed to be running. The next thing is what use can you make of the running plant and RIS is all about making the best use of that running plant in the ..short term [4].

The move from defensive to progressive investment in the refining sector did not occur overnight. While some refineries were being shut down, others were receiving capital investment to improve their effectiveness.

> ..you don't turn these taps on and off in quite a full sense. In the defensive period there were still investments taking place but they.. had to meet higher hurdles if you like, and now the taps aren't full on. One has to be cautious in terms of putting money in the right place [4].

However, RIS represents a particularly difficult investment to justify in an area of surplus capacity because of the nature of the benefits it seeks to provide.

> [T]hese things cost millions of dollars [and] if.. the refineries wish to spend that sort of money then they have to be sure that they're going to get the benefits. For example, you could equally well spend that money on de-bottlenecking a piece of plant where you would have, virtually anyway, guaranteed benefits.. The alternative is that you have faith in computer systems and spend the money, the idea being to get the last drop of cents per barrel of crude you process [20].

Even now refining margins, particularly in Europe, are quite small, but the major change that has occurred as a result of the shutdown of surplus capacity is that in the long term those margins are at least positive. With a glut of refinery products in Europe the activity of refining struggled to add value but with the renewed potential for profitable refinery operation RIS started to come into its own.

> If you're going to be competitive you can't afford to throw money away.. and most of the value opportunities there are oil based, as you might expect. I mean, what's the turnover here, it's about a billion dollars per annum. It doesn't take much of a swing in the value added activity to generate real bottom line improvements [4].

The magnitude of the potential benefits to be derived from a RIS system are dependent on refinery size, and Rotterdam is a huge refinery. Rotterdam refinery, partially as a result of its size, had major symbolic importance within BP. Rotterdam was a flagship refinery and its status as such may also have contributed to the decision to base the first RIS system there [3]. Thus, one can see that a variety of diverse factors combined to make Rotterdam an attractive site for the first RIS system implementation. We now go on to consider the second RIS implementation which occurred at BP's Bulwer Island Refinery in Australia.

The Second RIS Implementation: Bulwer Island's Oil Management System

A Common System For All BP Oil's Refineries

RIS systems are being implemented at all of BP Oil's strategic refineries worldwide [20]. Although there are important differences between the various implementations, each of the systems seeks to fulfil a similar function:

> The objectives of the system are to take operational information and hold it centrally and then to analyse that information in terms of commercial rather than operational criteria [22].

The $24 million spent on the Rotterdam RIS was seen to be a worthwhile investment by BP Oil and the organisation was able to satisfy itself that the benefits derived from the system outweighed its costs [20,4].

> The payback on a system like this is very difficult to calculate but Rotterdam suggested they saw a benefit of 17 cents per barrel [22].

A benefit of this magnitude is certainly significant when one considers that a refinery like Rotterdam processes billions of barrels each year [3]. Thus the organisation was keen to implement RIS systems in its other major refineries. Although the circumstances surrounding the Rotterdam implementation were unique the benefits derived were not seen to be solely dependent on those circumstances.

> In fact, the motivation in the Rotterdam case was arguably a little suspect but had a huge spin off and the huge spin off was a commercial improvement and that commercial improvement looked to be transportable across refineries [4].

The suspect motivation referred to above was the desire to solve the control problem brought about by the geographical separation of the manufacturing and supply functions. It seemed as if the system so produced could give managers who used it better commercial control of refinery operations wherever they were situated.

> You in fact ended up with a general tool for improvement which wasn't actually organisationally quite so dependent [4].
>
> It looked on the surface of it as if the software and the approach would have large areas of portability across refineries, so you wouldn't have to write the same software again [4].

BP Oil's refinery at Bulwer Island in Australia was chosen as the site for the second RIS implementation. The Bulwer system was known explicitly as an Oil Management System (OMS). Bulwer Island is a very small refinery, compared to Rotterdam [20] and it operates in a very different environment. The benefits expected from Bulwer's OMS system were not necessarily the same as those derived from the RIS implementation at Rotterdam.

> [Rotterdam] was obviously the most prominent refinery that needed such a solution. That's not to say that you can't get benefits from such systems in different ways at other refineries and so I suppose the first two implementations were poles apart. We had Rotterdam which is very volatile, things are changing incredibly rapidly there, great instability, variation of crude, you name it,..[with]..essentially a large scheduling problem that dominates your production and control problem. And then the second implementation in Bulwer which is...a refinery which serves a local market. Vessels are seen coming a month away,...so you don't have any volatility. However they have a different sort of problem which is in terms of competing plant in terms of essentially a mass balance problem and optimising the process operations was more critical there than at Rotterdam. So you've got the emphasis one end on process modelling and at the other end [on] scheduling and other refineries then will sit along that scale somewhere [20].

A desire to regain control of the <u>scheduling</u> of crude intake and product offtake was a primary driver behind the Rotterdam system but the concept of analysis of centrally held operational data was seen to have the potential to contribute to the solution of other refinery management issues. At Bulwer, where scheduling was less of a problem, the approach held out the promise of dealing with problems concerning how the various sub-elements of the physical refinery system were to be run, related, and co-ordinated. That is, those issues associated with planning the operations of the site. All of BP's RIS systems involve the use of Linear Programming techniques to assist in the optimisation of both the operation of process units and of the overall refinery system. It was upon this aspect of the RIS approach that Bulwer's OMS focused.

Competing Design Criteria: Site Specific Considerations vs. The Desire to Produce a Centrally Supportable System

> When we set out on the RIS project the idea was to make it as portable as possible and in fact 50% of the Rotterdam system was portable. The rest of it has to be tailored to the site and that's inevitable, but...the concept was that if you kept the core of the system portable then any enhancements at future implementations could be brought back into your other refineries [20].

The portability issue described above was difficult to square with the differing emphases on elements of the RIS concept that were applied at different implementations. Systems staff at Bulwer were well aware of the possible conflict of interests. The introduction to Bulwer's OMS Concept of Operation Document states that...

> It was a primary requirement of the OMS project to maximise the use of [Rotterdam RIS] technology in the implementation of the Bulwer Island OMS system, a key aspect of this technology transfer has been the initial adoption of the [Rotterdam RIS] data model as the basis for the development of the OMS systems.

> Without strict adherence to the [Rotterdam RIS] data model the relocation [of] any of the significant [Rotterdam RIS] software models would prove costly, if not impossible [23].
>
> The Bulwer Island OMS interface requirements precluded strict conformity to the [Rotterdam RIS] model. However, strident attempts were made to minimise the impact of these differing requirements and maintain the ability to utilise [Rotterdam RIS] software [23].

The same fundamental entities were used to make up the business model of the refinery at both Rotterdam and Bulwer Island and this level of similarity was maintained in the data models of the two systems [23]. The seven key entities of the business model are:

> CONSTRAINT, GRADE, MOVEMENT, NODE, QUALITY, PLAN, SCHEDULE
>
> It is through these entities, their sub-types and associations that a description of the physical refinery, the plans for its use and the history of its use are represented [23].

The nature of the primary management issue at Bulwer Island was markedly different from that at Rotterdam, as we have seen. The focus upon process modelling at Bulwer lead to a decision to abandon the planning and scheduling systems that had been developed at Rotterdam in the first RIS implementation. This had implications for the data model to be used in the Bulwer system.

> A major departure from the [Rotterdam RIS] model became unavoidable when the decision was taken to drop the use of both GRTMPS and BPRSS [the linear programmes used in the Rotterdam planning and scheduling systems, respectively] from the OMS Planning system in favour of the MIMI suite of products [23].
>
> MIMI, which stands for Manager for Interactive Modelling Interfaces, is a flexible interactive front end for modelling applications marketed by Chesapeake Decision Sciences. It provides an integrated framework for bridging applications programs, databases and distributed computers with a common interface [24].

MIMI comes with a module that "...provides the capability to generate, solve and report solutions to LP problems" [24].

In fact, there were...

> ...a number of major departures from the [Rotterdam RIS] data model in its implementation at Bulwer Island in order to accommodate the very different interface requirements of the Bulwer Island OMS system [23].
>
> Given the inevitability of these departures...and the consequent impossibility of 100% [Rotterdam RIS] compatibility, it was seen as pragmatic, and desirable, to improve upon the [Rotterdam RIS] model [23].

As we noted above, the OMS and Rotterdam RIS data models were still made up out of the same key entities but the way in which those entities were represented and ordered had changed. The OMS model standardised certain elements of the Rotterdam RIS model, extended the use of database wide unique identification tokens, extended the use of network tables, and minimised data duplication by removing special interface tables and standardising the storage of a variety of production targets [23].

Other design criteria also contributed to the shifting of the OMS model away from its Rotterdam RIS model starting point.

> The objective of the OMS system is to provide the tools with which the refinery staff may maximise the refinery added value. The major plank of the design of these tools has been to ensure that they are data driven. This design requirement has had, not unexpectedly, a significant impact on the design of the OMS database and the direction of departures from [Rotterdam RIS] [23].

Changes to the OMS LP and Process Modelling Systems

The implications of Bulwer Island's attempts to improve upon the Rotterdam RIS system were far reaching. Substantial changes were made to the system. These included changes to the database structure, architecture, and reporting. Radical changes were also made with regard to the way in which the process optimiser models were integrated into the site wide linear programming model [15]. These changes were made during 1988 and at that time it looked as if the Bulwer OMS system would become an improved "Mark II" version of the initial Rotterdam RIS. The Bulwer model was expected to become the BP standard. However it soon transpired that the proposed changes could not deliver the benefits they promised without significant costs and the Bulwer team were forced to backtrack [15].

One of the systems managers at Grangemouth had this to say:

> With any RIS system you have initially the data capture systems, historical data capture, of which you've got process data, tank data and lab data at the core. Analysis of that data to identify where problems were is one part of the system where you can get some benefits...The ambition with RIS was always to do a lot more than that and to actually build systems which looked forward in time, predicted what we were going to do, and did that in sufficient detail to provide advice, to the operators at least, about how they should operate the plant. So the idea was also to shorten the time frame on that look ahead period so that you almost had real time optimisation of the refinery. That was the ambition [25].

The aim was to provide a fully coherent, and implementable, short term production plan for the whole refinery.

> ...so you would have an LP [Linear Program]..[and] that LP would drive in some way the optimisers which were responsible for providing the advice for the process control. Rotterdam did a little bit of that but still the systems were quite separate. Bulwer Island tried to really integrate them and...they devised a

system where [the process optimisers, for example the catalytic cracker optimiser] did multiple runs, hundreds of runs and produced lots of sets of data for different types or by varying operating parameters. So then when the LP ran and decided at any stage of its solution what operating parameters it was going to use at that stage, it could go off to this database of the data from the optimiser and say that's the best fit at the moment, bring that back as the yield structure we're going to get if we run on those operating parameters. Now as the LP went through its iterations it would continually go out and access this database and get a better and better fit [25].

Thus the optimisers were run for a large number of iterations and then the LP was run for fewer iterations and it picked out the best of the optimisers' iterations each time. After the initial population stage, the data set of optimiser performance was built up from the past actual performance of each process unit within the overall system. That is, the optimiser performance data set was a record of the best <u>actual</u> past performance of the unit in question. It was a record of how the unit had been seen to perform in the past, not a theoretical calculation of how it <u>should</u> perform.

> Bulwer Island's approach was...to extract the running sets rather like still frames in a movie film. They were going to trap all these and basically record it as a history of options and have some logic which allowed the planning function to be based around what had actually happened in the past. And they ran into problems with software which could trap that amount and sort out the logic of picking one...in some sort of optimised fashion. It meant that they had to choose a different type of LP optimising package or write different sorts of interfaces. Instead of taking a cat cracker and saying, well, I have sixteen options - I can go maximum throughput, minimum throughput, maximum crack spirit, minimum crack spirit, and so on and so forth, all the sort of traditional parameters - what they did is they were looking for something like a hundred options out of their last two months, two years, whatever, operating practice. It meant they didn't have to worry about models, they just referred to fact...and you could pick the best actually achieved operating practice out of the past and set that as a target for the future. I found it in a theoretical sense rather attractive. But they seemed to run into a lot of problems in terms of integrating that with their LP systems and so on. They bit off more than they could chew and I don't know what's happened to that project [4].

> They tried to be technological innovators I think it's fair to say at Bulwer Island and at one stage it looked as though they were going to overtake the BP world....They may have done so but I think they had to change their whole system mid-stream. They ran into technical problems which were quite substantial [4].
>
> The technical problem really was in driving the optimisers to generate a database which you could actually understand and was suitable for solving the bigger problem and they never really cracked that problem. If you can imagine that those optimisers were filling a sort of three dimensional space with lots of data points and the LP was going in and finding the best point based on the sort of feed used, appropriate points on a blend, and interpolating between them. The theory of what they trying to do was very complex and so was putting it into practice, just because of machine time restrictions and so on. That planning part of it didn't work and because the target setting bit [which was dependent on the planning part] was integrated with some of the other systems, like reconciliation, two or three other systems sort of fell apart because they wouldn't work. So they had to fall back to the initial data capture system [used] in one or two of the more straightforward systems [25].

The not altogether successful alterations that Bulwer made to the Rotterdam RIS, and particularly those changes made to the core Rotterdam data model, had wide ranging implications for the programme of RIS implementations that BP Oil had embarked upon. Grangemouth in particular was faced with a difficult choice over which model to adopt. We will return to the specifics of the Grangemouth implementation in the next section. One of BP Oil's refinery analysts had this to say about the long term effects of Bulwer's divergence from the core Rotterdam RIS system:

> What actually happened was that Bulwer were allowed to destroy the core of the system and...we've ended up with two RIS systems essentially within the RIS group, within the BP group. And it means that any future implementation has to choose a starting point between one of these bits of software, you either go Rotterdam software or you go Bulwer software...I still believe we should've harmonised worldwide but that's water under the bridge really and we just sort of have to face the problems we have. What it has done of course is to create a tremendous support problem because we're not now able to set up any kind of central support. You can argue that you need a lot of on site support

> anyway because it's the site specific bits that require the most attention but having said that we've completely precluded any kind of central support and I think that the cost of supporting that software has probably increased because of that...There have been mumblings about actually getting a software house to productise it so we can sell the RIS system elsewhere and in that way we would share with other oil companies, not just within BP but worldwide other oil companies, would share the sort of maintenance and enhancement costs...[W]e're too far down the line with our current RIS implementations to actually consider it at this point but for the next generation of RIS systems I think that's the likely starting point. So you basically build yourself a tool kit and you can sell the tool kit without selling [the] business concepts which generate the cash, in theory. I just have one hang up about that and that's the fact that having sold the models of this system and defined the interfaces, the data in the interfaces will basically give away the business secrets. But again, I mean that's my view and other people disagree with that [20].

Although the failure of Bulwer's "technological leap into the future" [4] prevented it from coming the Mark II of RIS and a standardised starting point for future RIS implementations, its partial success somewhat scuppered BP Oil's hopes for central support for the core elements of a number of partially customised RIS systems in their refineries throughout the world. However, if the OMS experiment had been more successful at Bulwer and the approach had been adopted at BP's other refineries the organisation could've found themselves facing even greater problems at future implementations.

> The...thing about Bulwer which you shouldn't forget is that it's a very, very small refinery and therefore you can build into the LP representation all the detail, and you can do your scheduling within the planning program in the LP. If you try scaling that up to a larger refinery everything increases in size exponentially and becomes completely unmanageable with [the computer] hardware [currently available]. This is the danger of these systems... Let's say [that] Bulwer had worked, I still think it would have been a difficult thing to superimpose as such on Grangemouth for example and almost impossible to put into Rotterdam...Just to give an idea,...Grangemouth might make one MOGAS [motor spirit] blend a day [whilst] Rotterdam would make five a day on average [and Grangemouth is a substantially larger refinery than Bulwer Island]. The scale up problem is much, much greater. RIS is

actually a tool kit. I mean you basically take the concepts and the software that you have available and then you jiggle it about to represent local circumstances [20].

RIS: a "Configurational" Technology? [26]

The Rotterdam Refinery Information System and the Bulwer Island Oil Management System may be considered as examples of what Fleck [26] has termed "configurational technologies" [27].

> Configurations..essentially comprise more or less unique assemblies of components, some standardly available, others specially developed, built up to meet the particular requirements of a user organization [26].

Fleck contrasts configurations with "generic systems" [26]. Generic systems possess: identity across instances; a certain systematicity governing the integration and relation of components; and an inherent logic which structures development [26]. Configurations, lacking these attributes, are consequently more dependent upon the contingencies and particularities of application, including varying user demands.

> Configurations differ from generic systems, in that there is a greater looseness or "ad hoc-ness", and a lack of systematicity, about configurations. The overall "shape" of the configuration stems from the particular requirements and exigencies of the application addressed [26].

The uncertainty inherent in the development of configurational technology systems creates opportunities for, and indeed necessitates, radical large scale innovation at the application site. The oil management systems developed at Rotterdam and Bulwer Island and described above certainly seem amenable to this characterisation.

With generic systems, requirements are pre-defined through the activities of market mechanisms which serve to embody prior application experience in the "bog-standard" system. Generic systems are most applicable to well defined, tightly specified tasks, where contextual stability is achieved through a dynamic balance of contingent elements and alliances. These conditions do not tend to pertain where configurational technologies are employed. The creation of a configuration seeks to establish stability at the application site, but this stability will not necessarily be transportable with the technological elements of the system. As similar systems are built at different sites a process, termed "innofusion" by Fleck [28], is established where diffusion and innovation are "collapsed together" [26] with a number of differences and similarities being established between versions of the system. The areas of similarity and difference are not necessarily stable between different versions and are wont to change. Similar contingencies at different sites may stimulate the solidification of system similarities, but these can easily be disrupted by differing circumstances.

> But in all cases, through the process of building a configuration equal to coping with local exigencies, certain local contingencies may literally be reified - i.e., translated into artefactual form, and crystallized as a distinct technological component from out of a fluid mixture of social, organizational and other technological and non-technological contingencies [26].

This is not to suggest that designers and implementers are dupes in such a process. As Fleck [26] notes "new characteristics may be <u>explicitly</u> developed in response to requirements or environmental exigencies, by recombining existing components, and then <u>directly</u>

transmitted to succeeding generations of technology." New components may also be added, and old ones dropped, as we saw at Bulwer.

Thus although the espoused intention of BP Oil's corporate centre (at least following Rotterdam RIS) was the development of a generic system to facilitate oil management at a number of different refineries, the distinctiveness of the first two application sites resulted in the creation of two distinct systems, or configurations.

Fleck has suggested that stable generic systems may emerge from configurational technologies..

> ..once knowledge about the ranges of possibility open to the configuration has been developed, and subsets of those possibilities which exhibit a degree of internal consistency have been identified, and for which a market demand is evident [26].

As we will see later, a market demand for RIS, even within BP, was far from evident. There may indeed have been a demand for a management system at each site, but for systems with very different characteristics at each of the different sites.

Stable generic systems do not necessarily emerge from repeated configurational applications and the likelihood of such stabilisation decreases with increasing complexity and variety of applications.

> In many situations (and currently many large-scale IT systems seem to approximate these), local contingencies continue to resist stabilisation or crystallization, and development involves a sequence of highly individual configurations - a sequence, moreover, which is not necessarily progressive [26].

The corporate ambition within BP Oil was for a system that could be treated, at least partially, as a black-box [29]. This had certainly not been achieved by the end of the second RIS implementation and such a stabilisation may well not be achievable, even after a number of implementations. A succession rather than a progression of system versions would seem to be a more likely outcome. Not only were staff at Grangemouth presented with two competing configurations, they were also to face a great deal of site specific uncertainty and contingency of their own in their search for an implementable system. In the next chapter we consider in detail the emergence of RIS at Grangemouth.

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15. Interview: Senior Manager in Systems Group of Manufacturing and Supply Business Development Unit BPOI Corporate Centre, London 25th March 1991.

16. Telephone Conversation: Systems Manager 1 (Grangemouth Refinery) 11th December 1991.

17. The title "Rotterdam spot market" with its geographically situated connotations is perhaps something of a misnomer. The name derives from the fact that much of the product trading carried out in the market is dependent on the movements of products, by barge, up and down one of the main North European rivers, the Rhine, which emerges in the vicinity of Rotterdam [16]. The Rotterdam spot market is the European instantiation of these developing intermediate markets. Other world centres have their own markets [18].

    Rotterdam has a high concentration of refineries. It's at this end of the Rhine, hence it's the focal point for much of the supply system into Germany and for that reason it's the largest centre for oil movement in North West Europe, and hence people use this term, the Rotterdam spot market [3].

    There was a little cartoon in one of the papers when oil prices hurtled up which had these two dear old souls in their car, and he's driving and she says to him "Are you sure that if we find the Rotterdam spot market it will still be cheaper?" And that says it all, people use this term but the place, you know, there is no such thing [3].

18. Telephone Conversation: Systems Manager 1 (Grangemouth Refinery) 12th December 1991.

19. The system implemented at Brittanic House to provide information on refinery stocks to the remote H.O. supply function was actually known as "RIS1" and the refinery based RIS system that was later introduced at Rotterdam was known as RIS2. For ease of reference in this paper the RIS1 system is referred to as the "SIS" system whilst the RIS2 system is referred to as the "Rotterdam RIS" system.

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26. Fleck, J. (1992) "Configurations : Crystallising Contingency", Edinburgh PICT Working Paper No. 40

27. As our earlier perusal of the work of Callon, Latour and Law shows, all sociotechnological arrangements are configurational. Fleck's point is that some are more evidently "configurational" than others. Such systems bring into sharp relief the wider insights made by associologists.

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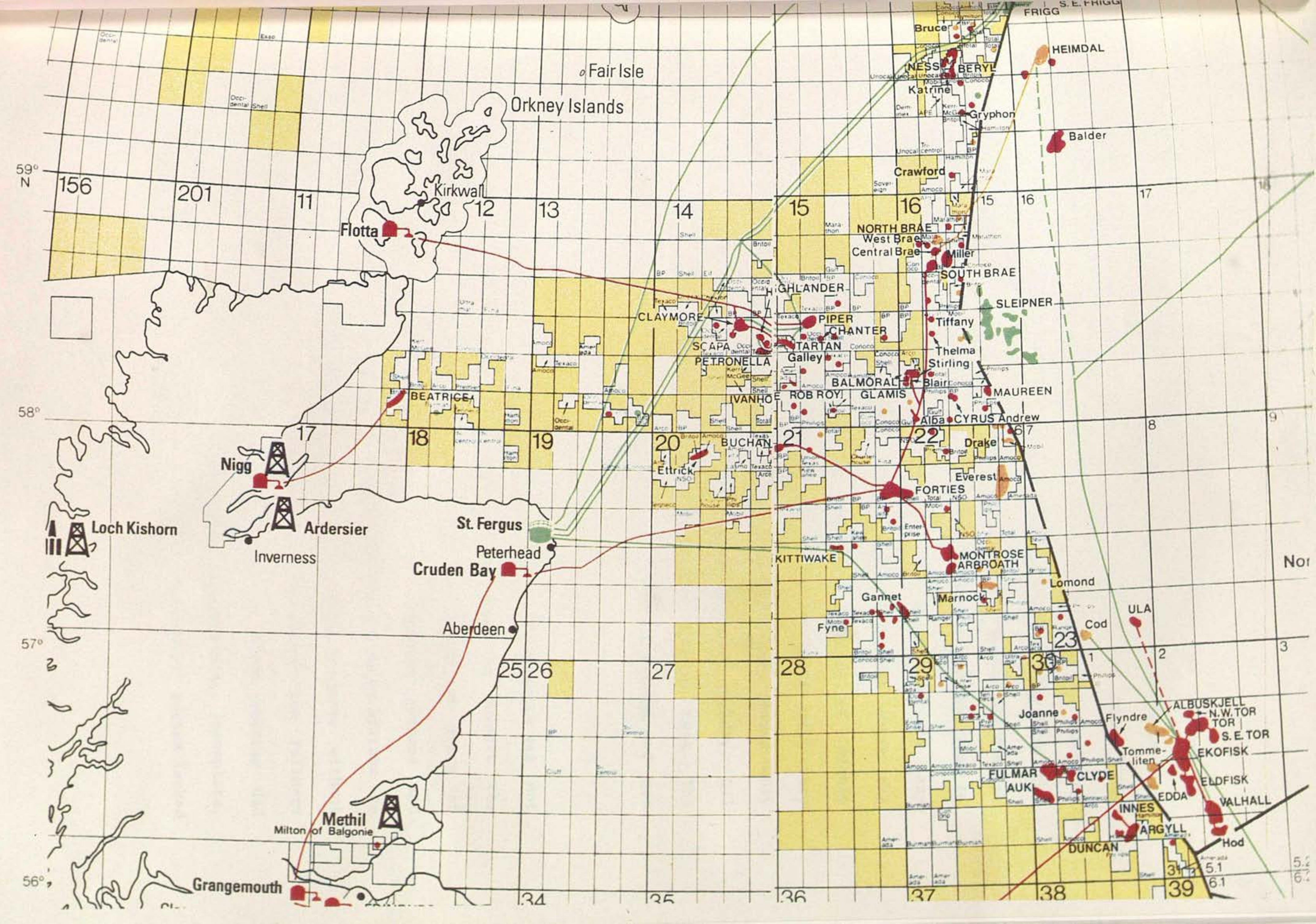
CHAPTER FIVE

THE GRANGEMOUTH REFINERY INFORMATION SYSTEM (RIS)

Introduction

Grangemouth refinery is situated on the Firth of Forth in Scotland. Within the BP organisation the refinery is currently owned and operated by BP Oil UK whose headquarters are in Hemel Hempstead. BP Oil UK is represented at the headquarters of BP Oil International (BPOI) in London by BP Oil Europe which also represents BP Oil's European corporate operations. As we noted in the previous section, Grangemouth is now BP's only crude oil refinery in the United Kingdom [1].

In the early 1920's the Anglo-Persian Oil Company, later to become known as BP, became interested in the establishment of a small refinery in north-east England to meet the local needs of Tyneside, Scotland and the Scandinavian market. In 1919 the Anglo-Persian Oil Company had acquired a company, Scottish Oils Limited, that had recently been formed out of the six scottish oil companies that had survived the changes that the oil industry had undergone during the late nineteenth and early twentieth centuries. This recently acquired subsidiary persuaded the Anglo-Persian Oil Company that it should look instead at the flat ground to the east of the growing town of Grangemouth as a possible site for a new refinery to serve these markets. Grangemouth not only offered a suitable site and a port for crude carrying tankers but also a proximal nucleus of labour skilled in shale oil technology. The refinery was therefore built at Grangemouth and began production in 1924 [1].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CLAYMORE
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Tiffany
SCAPA
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Thelma
Stirling
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BEATRICE
IVANHOE
ROB ROY
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Andrew
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Drake
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FORTIES
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Marnock
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FULMAR
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CLYDE
INNES
ARGYLL
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ELDFISK
EDDA
VALHALL
Hod
FRIGG
S. E. FRIGG
HEIMDAL
Balder

Today, crude oil enters Grangemouth refinery from two sources: a harbour and bulk storage depot at Finnart, via a cross-country pipeline; and a Forties Field pipeline from the North Sea. Crude from Finnart may have been bought direct from any of the many oil exporting countries, or from the Rotterdam spot market. Crude entering from the Forties pipeline may have come from any one of the several oil and gas fields connected to the Forties system. Oil is sent along pipelines in consecutive "slugs" which do not mix with each other to any significant extent. Thus crudes of different qualities enter the refinery for blending and processing into a range of highly standardised products. Even feedstocks from any one field will vary over time and, although the product specifications change only infrequently, the volume demanded can and does change rapidly. Oil management at Grangemouth is therefore a very complex task. The refinery's products are distributed by road, rail, pipeline, and sea [1].

The Refinery Information System (RIS) project at Grangemouth was not the first attempt to introduce computer technology to support the operations of the refinery. It followed a number of years of significant investment in the development of computer systems and hardware at the site. However, virtually all of the major systems in place were developed and implemented as individual projects without any serious consideration of the overall structure of the refinery wide system that was so created [2]. Some of these systems did communicate with each other but the links were cumbersome, incomplete, and expensive to maintain and, consequently, the overall system lacked coherency. As a result of this piece-meal approach there was perceived to be a large amount of useful information potentially available that was not being used to best effect [2].

Initiating RIS at Grangemouth

In 1987 a Strategy Study concerning oil management systems at Grangemouth was undertaken by the Systems Group of the Business Development Unit (BDU) for Manufacturing and Supply (M&S) [3]. As we noted in the previous chapter, BDU's are part of the BP Oil International (BPOI) organisation at the corporate centre in London and are charged with directing the strategy of those elements of BP Oil's business for which they hold responsibility. BPOI has separate BDU's for Manufacturing and Supply, Retail, and its Commercial business areas [4].

The Systems Group Strategy Study came hot on the heels of the first BP refinery based RIS system which was under development at BP Oil's refinery in Rotterdam. According to one member of the M&S BDU who had been involved in the design and implementation of the Rotterdam system, the concept of a refinery based RIS system first surfaced at Rotterdam in 1985 [5]. A European refinery analyst, a member of BP Oil Europe's Manufacturing Development Group said that...

> ...the vision some years back, and I suppose this still exists, [was] that over a period of something like ten years, from the mid-eighties,...we would get the RIS type system into all of our refineries worldwide [6].

The Grangemouth Strategy Study "...focused on Oil Management Systems as we believe that the major benefits are to be derived from systems in this area" [3]. The proposals that emerged from this study were "...modelled closely on Rotterdam Refinery's [RIS] system philosophy"...which has.. "..been fully accepted by BP Oil International (BPOI) as the standard for all the Group's strategic refineries" [3]. Grangemouth is one such refinery.

Grangemouth had not been as dramatically affected by the changes that occurred in the European oil market in the early eighties as had Rotterdam where the development of the spot market was accompanied by a demand for a large number of comparatively small shipments of a variety of products carried by barge. One of the Grangemouth managers with some responsibility for systems development at the refinery had this to say about the differences between the two sites:

> [Grangemouth] is not a site...where the intermediate market developed so early, nor was it voluminous,...[and] it's not barge orientated. You could handle the amount of..ship[ment]s that were sold to third parties from here, if you like, by hand. You could not handle the amount of barge volume taking place out of Rotterdam by hand. It was just, the co-ordination required, the speed of response, was not possible [7].

The manager quoted above saw that many systems at Grangemouth were being implemented in response to Head Office pressures rather than to the particularities of the refinery's operating conditions. Because projects were not being conceived to meet needs expressed locally management often had to struggle for local support [8]. He saw a problem with the "partial solutions" that resulted from such an approach. Tools were not being implemented with regard to wider issues and they were therefore not achieving inroads into coping with the refinery's "critical success factors" [8]. This manager was not aware of any local demand for the RIS system that was articulated before it was already pretty clear that the site was going to receive such a system [8].

> If a solution has been successful elsewhere it becomes a potential solution depending on a degree of local support which obviously may be open to political manipulation. Often the tool may not in reality be the solution [8].

> [The Grangemouth RIS] did not come from the refinery. I think I've mentioned before that RIS came out of Rotterdam where it seems to have come out of attempts to meet the information accessing needs of a group of remote decision makers... Then this whole RIS thing of single planning and control of the refinery activity and scheduling timetable arose [9].

Remote decision makers at the BP Oil UK (BPOUK) Head Office at Hemel Hempstead did have a role to play in the running of the Grangemouth refinery but the extent and impact of their influence was far smaller than was the case at Rotterdam. The need at Rotterdam was for something that would make information available...

> ...to the decision makers who in that organisation were remote, and in many refineries are actually remote or distributed. As far as Grangemouth is concerned there is a degree of remoteness about the Hemel supply operation but because the distribution of products from here is essentially ship followed..by pipeline... followed by rail and road, the parcels are bigger and that tends to mean that the planning ahead is slightly longer than the Rotterdam barge type traffic. Nonetheless, the principle was seen as very effective and...they did that first project audit on Rotterdam and despite I think spending $25 million on the whole damn development they were able to satisfy themselves that they got value for money out of that and therefore thought they'd hit upon a competitive edge. And BP is pursuing that around it's major refineries and [Grangemouth] is certainly a major refinery [9].

Despite the cynicism displayed in the earlier quotes, this manager did see a RIS at Grangemouth as being potentially useful. He went on to say that...

> The concept of taking control of the production of the site is valid. The tools that were in place before the RIS concept came along knocking at the door... two or three years ago... were primitive, slow [and] fragmented. The operations of the plant were set on one set of assumptions which would be changed more rapidly than you could re-plan the effects of those changes. And it's actually speeding the whole process up to that degree of coherence which attempts to put you in control [9].
>
> I'd put it in terms of how long does it take you to produce a plan, and how good is the plan. And I would summarise the RIS objectives as saying that it must produce an implementable short term plan for the refinery within four hours, or close to it. And if it can do that then it will succeed in terms of being able to change the direction of the whole refinery, not bits of it, but the whole refinery consistently, and therefore avoid nasty surprises from changing bits, meeting those bits only to find that other bits of your scheduling operations all unwind [9].

We now go on to consider in more detail the development and implementation process of the Grangemouth RIS.

<u>The Grangemouth Oil Management System Strategy Study, December 1987</u>

The vision within BP of getting "the RIS type systems into all of our refineries worldwide" [6] had its first significant impact on the Grangemouth refinery in 1987 with the commissioning of the Strategy Study mentioned in the previous section. According to the report produced by this group "all the major oil companies are actively engaged in the development of computer information systems in refineries" [3]. As we have already noted the information systems proposals put forward in this report were "modelled closely on the [Rotterdam RIS] philosophy" [3]. Through the Rotterdam RIS project BP was seen to have taken "oil management system concepts a good deal further than most of its competitors" [3] and the intention was to build upon the perceived advantages derived from this lead by rapidly deploying RIS-type oil management systems into all of the group's refineries.

The Strategy Study's focus on oil management systems was justified in terms of the benefits to be derived from improvements in this area relative to those derivable from further information systems support for other aspects of Grangemouth Refinery's operations. This focus of approach was partially predicated on the existence of a number of other systems at Grangemouth. These systems were thought to have already led to significant improvements in other areas potentially served by an integrated refinery based system, such as loss calculation and custody transfer management [3]. These areas were not seen to fall within the remit of the RIS Strategy Study. "[RIS] studies are concerned with the optimisation of operations within the refinery" [3]. Areas such as the two mentioned above and oil accounting were explicitly excluded [3]. The authors of the Strategy Study were keen to utilise existing systems at Grangemouth in any subsequent development of RIS at the site.

> As the refinery already has a considerable investment in many of the components of a [RIS]-type integrated oil management system the proposals we make build on these developments in order to exploit their full potential [3].

Predicted Benefits of the Strategy Study Team Proposals

The main benefits were seen to be in the planning and scheduling areas of refinery production. Specifically, benefits were to be derived from "the integration of refinery models" [3]. That is, from the integration of the various Linear Programs, developed in London and Hemel Hempstead, which modelled (i) the behaviour of various elements of the refinery, (ii) the refinery as a whole, and (iii) the activities of groups of refineries within BP Oil. Within Grangemouth, slightly different models were used for planning and scheduling operations and another set of models was used to provide optimal modes of operation with regard to the added value to be derived from activities. These optimised models were also used to provide predictions of performance in order to facilitate the monitoring of actual performance.

The Strategy Study Team acknowledged difficulties in calculating the precise extent of these improvements in performance but they did feel able to point to the main sources of the benefits thought to accrue from an integration of refinery modelling:

> i) Consistency of [Linear Programming] (LP) models between the refinery and head office.
>
> ii) The global optimum [or overall Grangemouth value added performance] will be improved by the feedback of key data from the on-line plant models into the refinery LP model.
>
> iii) Better commercial decision making as a result of improved representation of the refinery in the head office LP model.
>
> iv) Schedules which are, as far as possible, consistent with the LP plan and which fully recognise the constraints of the site. Benefits expected from:

- More accurate scheduling.
- More accurate prediction of rundown quantities and qualities for blending.
- More optimal use of components.
- Reduction in quality giveaway [i.e avoiding selling high quality, high value products for the price of low quality , low value products by improving the information available on product qualities].

v) The use of predictive versions of the on-line plant models [models for optimisation] and the simplified models [planning models] for planning purposes. These models are currently being developed for the [Rotterdam RIS] system [3].

The remit of the Strategy Study Team was obviously not confined to consideration of the potential impact of RIS on the internal operations of the refinery. The relationship between refinery operations and the remote Supply Division was also considered.

> As well as talks with a number of key staff in Grangemouth Refinery we have also discussed the commercial links between the refinery and head office with the manufacturing and supply functions in London [3].

<u>The Planning and Scheduling of Production at Grangemouth Before RIS</u>

At the time of the Strategy Study the planning of refinery production was carried out "jointly" by head office and the refinery. A number of different computer systems were used to facilitate this process. Planning for periods of between one and three months ahead was undertaken by head office staff using a Linear Programming (LP) modelling system run on IBM computers at Hemel Hempstead [3].

> This model..covers the whole of BP Oil's operation and differs from the short term refinery model used on site. The model is used for selection of crudes, including the economics of purchasing Forties mix. Once the monthly plan is established, it is agreed with the refinery at a monthly meeting. This estimate forms the basis for [overall refinery] performance monitoring comparisons, though this activity does not extend to re-running the model using actual crude runs [3].

The one to three month plan established by the refinery and head office was broken down at the refinery into operating blocks of between three and thirty days, the average being about five days. The actual block length was determined by the periods of time for which the operation of the process units remained "stable", given the inputs provided and the production required [3]. Changes to either the relative or absolute amounts of the products required, or to the amount or compostition of the feedstocks available had, and continue to have, significant implications for the stability of operations.

As many as four estimates of production were carried out each month, with the precise number depending on the "stability" of the programmes suggested.

Planning Production at Grangemouth Prior to RIS

Production Planning at the refinery was carried out using a system unique to Grangemouth which was run in house on the refineries VAX computers. The system consisted of a suite of Fortran programs, developed in the early 1970's which were subsequently linked to an overall refinery LP planning system designed by Scicon [3]. BP bought Scicon in 1966 and by 1984 it was the biggest computer services company in the UK [10]. Scicon was sold by the group in 1990 [11].

> Key component stock data are manually input to the [Sciconic refinery] LP model, for each block, to simulate offtake patterns appropriate to the feedstocks in each period. The definitive offtake programme is not confirmed until just prior to the week in question [3].

Three main programs from the Fortran suite were in use at the time of the Strategy Study. Two programs were used to predict the operation of the various refinery process units for different modes of operation and feedstock mixes. The third extracted data from the first two in accordance with the recommendations of the Sciconic overall refinery LP model. That is, it picked out data on the mode of operation for each unit that was deemed most appropriate by the overall Sciconic LP. From this data the third program also generated "an operating programme which can be given directly to operations staff. This programme [was] automatically downloaded to the [process control system], to provide planning targets" [3].

It is important to note here that the output of the Fortran programs was not used to directly control the operation of the process units. The third program provided targets which were displayed on the process control system to the operators of that system. These individuals used the process control system to control the operation of the process units. They carried out this control on the basis of the targets provided, but the <u>actual</u> control of the units was mediated by their judgements. The computer system carried out the calculation of the optimal programs but operations were actually controlled by the process unit operators in the light of contingent conditions which were often not taken into account in the computer's calculations. As we will see later, this separation of optimisation from control was maintained throughout the development of the Grangemouth RIS.

Scheduling Refinery Production at Grangemouth Prior to RIS

At the time of the Strategy Study, the actual scheduling of refinery production was considered to be "essentially a manual task" although the process could be assisted by the use of BP's Refinery Scheduling System (BPRSS) "for feedstock and blending areas when appropriate" [3]. Feedstock scheduling tended to be relatively straightforward when the refinery was using the comparatively homogeneous Forties mix by itself but it could become very much more complicated if feeds from other sources were used. BPRSS was used in these circumstances, with its use for this purpose being required, on average, twice a month [3].

For most of the time, the stability of operations allowed the use of a "stripped-down" version of the Sciconic LP planning model for component blending optimisation. The stripped down version of the LP covered blending operations only and this tool was preferred to BPRSS as the full blown model required the collection and input of more detailed data than the former. Final calculations of individual blends were carried out using a spreadsheet in order "to take account of actual process rundown qualities, predicted component tank qualities and product tank bottoms" [3]. A copy of this spreadsheet was transferred electronically to Hemel Hempstead [12].

The proposals for developing production planning and scheduling at the refinery that were put forward by the Strategy Study Team were explicitly in line with the overall development process ratified by BPOI and exemplified at Rotterdam.

> The fulfilment of the concepts now being further developed by BPOI calls for the complete integration of planning (monthly and block estimates), scheduling (feedstocks, process and blending areas) and process models (on-line and off-line models)... The ultimate objective of the system is to produce realistic targets which, if achieved, will maximise the value added to the feedstocks [3].

The recommendations of the Strategy Study Team were "based on these concepts" and were intended to "enable the refinery to move closer to these objectives" [3]. Their proposals also had implications for the Grangemouth-Head Office relationship. In particular, it was suggested that the refinery and Head Office should use the same basic LP representation. The Strategy Study Team recommended the use of the Head Office LP at Grangemouth in place of the Sciconic refinery LP that had been used in the past. As the Head Office LP embraced the whole of BP Oil's operations, it was suggested that Grangemouth staff should maintain only that portion of the model that pertained to the Grangemouth refinery. Thus the proposals were seen to "require very close co-operation between the refinery and head office LP users" [3].

With regard to scheduling, the Strategy Study Team focused on the under utilisation of the BPRSS. It was suggested that the availability of better data capture facilities would go some way to rectifying this situation. These facilities were to be provided by another project ongoing at Grangemouth, the Process Instrumentation Project (PIP) which is described in detail later in this section. The "integrated oil management information system" proposed in the Strategy Study Team's report incorporated "quantity, quality and movements tracking [information]..as well as information from the laboratory and head office supply functions" [3]. The automatic data capture required to support these aims was seen to be essential for increasing the use of

BPRSS in the refinery for feedstock and blending scheduling. Extensions to the BPRSS were also proposed.

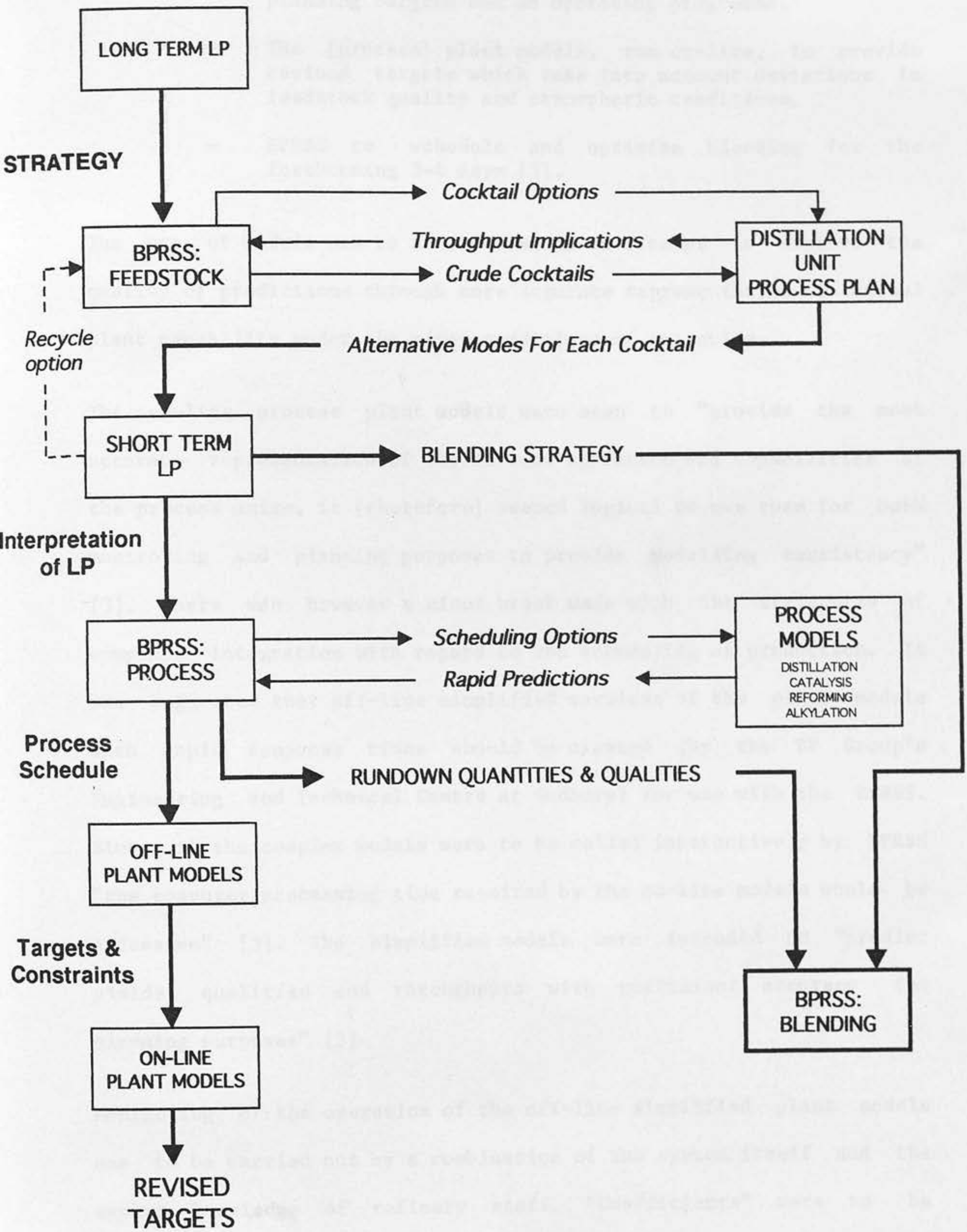
> Automatic data capture will enable the refinery to take full advantage of the existing BPRSS feedstock and blending area models. The use of an BPRSS process area model, linked to simplified process models.., would allow a more accurate representation of unit rundown streams [3].

<u>The Integration of Refinery Modelling</u>

The framework for the integration of refinery models for Grangemouth was explicitly adapted from a framework that was still under development at Rotterdam in 1987. The system to be developed was intended to integrate the whole production control function from the development of the long term plan by head office, through the short term refinery planning and scheduling stages, right down to the on-line models used to optimise the operations of the various elements of plant in use at the refinery [3].

> In essence, the components of the system [were]:
>
> - A 1-2 month strategic LP model, run by the head office.
> - BPRSS for feedstock scheduling to predict the crude cocktails which are to be processed.
> - [An LP model of the operation of the crude distillation units] to generate activities for the short-term planning model (3-10 days) for each cocktail and each operating mode.
> - The short-term planning model, run on a rolling basis every few days, to provide global optimisation of the refinery.
> - BPRSS, in conjunction with simplified [on and off line] process [plant] models [of the crude distillation units, the alkylation unit, the catalytic cracker, and the catalytic reformer], to schedule the process areas.

INTEGRATED REFINERY MODELLING SYSTEM



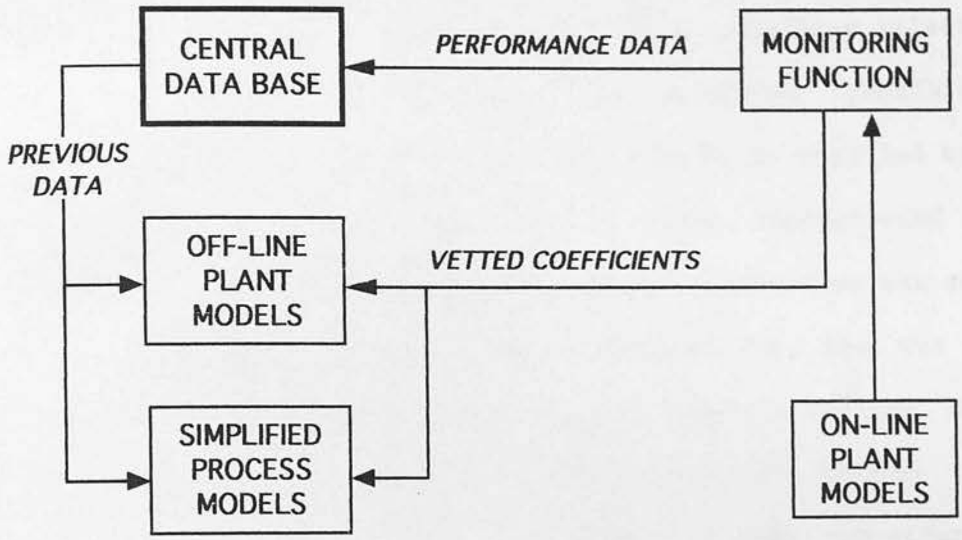
- The [process] plant models, run off-line, to generate planning targets and an operating programme.
- The [process] plant models, run on-line, to provide revised targets which take into account deviations in feedstock quality and atmospheric conditions.
- BPRSS to schedule and optimise blending for the forthcoming 3-4 days [3].

The use of models was to be extended in an attempt to improve the quality of predictions through more accurate representation of actual plant capability under the given conditions of operation.

The on-line process plant models were seen to "provide the most accurate representation of the current operation and capabilities of the process units, it [therefore] seemed logical to use them for both monitoring and planning purposes to provide modelling consistency" [3]. There was however a minor break made with the strictures of complete integration with regard to the scheduling of production. It was suggested that off-line simplified versions of the plant models with rapid response times should be created (by the BP Group's Engineering and Technical Centre at Sudbury) for use with the BPRSS. Since if the complex models were to be called interactively by BPRSS "the computer processing time required by the on-line models would be excessive" [3]. The simplified models were intended to "predict yields, qualities and throughputs with sufficient accuracy for planning purposes" [3].

Monitoring of the operation of the off-line simplified plant models was to be carried out by a combination of the system itself and the expert knowledge of refinery staff. "Coefficients" were to be generated by the system to relate the models to the physical

PROCESS MODELS FEEDBACK LOOP



conditions of the plant. The more complex versions of the simplified optimising models used by BPRSS were to be run on-line using the actual operating conditions of the run as inputs. The predictions of this run were to be compared with the predictions from it's previous off-line run, and a coefficient was to be calculated relating actual possible optimum performance with predicted possible optimum performance. These coefficients were then to be ratified by technical staff within the refinery before being incorporated into the simplified models used by BPRSS. Human intervention was seen as of vital importance here since the performance data that was stored in the central database was also captured from the on-line models, via the monitoring system, and this information became the primary resource used when attempts were made to improve the accuracy of the models used. "This step is essential to prevent the system from becoming self-fulfilling" [3].

The feedback of data from the process models into the three to ten day overall refinery plan was seen to provide benefits in terms of the overall performance of the refinery. These benefits were thought to accrue through the improved representation of units in the overall refinery model and through the greater accuracy of the overall refinery model so created. Feedback also had an important role in the maintenance of consistency between the different levels of representation used in the various models employed in the refinery. The revisable overall refinery model was to be used to define the "constraints within which the individual off-line and on-line plant models are able to optimise, and so ensures consistency between local and global optimisation" [3].

Proposals for Providing the Data Necessary for the Grangemouth RIS

As was mentioned earlier, prior to the instigation of the Grangemouth Strategy Study work was underway to improve the quality of the data capture systems in use at the refinery. A "Process Instrumentation Project" (PIP) was nearing completion. This project had involved re-instrumenting much of the refinery plant through the implementation of a Honeywell "Total Distributed Control" System. This system allowed the monitoring and management of much of the plant from a central control room. The data captured by this system was of "paramount importance" for the RIS project [3]. The existence of the PIP system was a necessary prerequisite for the implementation of RIS at the refinery. The main problem for the Strategy Study Team was to decide how to manage this data and its transfer to RIS. Ideally the Strategy Study Team wanted all plant data to be transferred to a central database to service other applications such as the process models. Such an approach would also "provide users with an enquiry and reporting capability ..and.. assist trouble-shooting investigations" [3].

> In principle, we envisage a system which would allow staff at all levels to gain access to summary data appropriate to their work, but in addition to retrieve the underlying detailed data if they wish to do so. As a consequence of the PIP system, Grangemouth is now equipped to provide much of this information [3].

A Strategy for Computer Support for Oil Management at Grangemouth

The proposals for the integration of planning and scheduling within BP Oil, the systems already available at Grangemouth, and the enthusiasm within the M&S BDU for the ongoing Rotterdam RIS project meant that for the Strategy Study Team the only sensible course to be followed to improve oil management at the refinery was the implementation of a RIS type system built around a central database.

> The new concepts developed by BPOI for oil management systems demand the highest levels of system integration which can only be realised by having a unified common structure for the data, which is stored in a central database. In this way, all systems and users have free access to the data via a common pathway [3].

The central database in such a system was seen to provide two complementary benefits. Firstly it acts as data communications link providing an efficient and "tidy" means of conveying information between various sub-systems and secondly it provides users with a window for viewing the operations of the refinery and a single source of information to support the ad-hoc and pre-defined enquiries required for oil management [3,5].

Prior to the implementation of RIS, base level computer knowledge at the refinery was considered to be "low" in relation to other elements of the BP organisation, such as BP Exploration [2]. This potential deficiency was taken into consideration by the Strategy Study Team who noted that..

> To be of real use to staff who are unfamiliar with computers the database system must be flexible and friendly and the data structures must be understandable [3].

To this end the ORACLE "fourth generation language (4GL) [is] preferred by BPOI..and this software product is being used in Rotterdam's [RIS] development" [3]. This product, at least in the configuration in which it was implemented at Rotterdam, allows users to be provided with pre-defined screen-based forms that can be parameterised, by relatively inexperienced users, and used to download information for perusal or further analysis on simple packages [13]. We will consider in more detail later how access to information was actually defined in practice.

Only relevant, oil related, data was to be passed to the central database of the Grangemouth RIS system [3,5]. Within such a framework individual subsystems were to retain their own working databases and either a subset or all of the information contained therein would be periodically transferred to the central RIS database. For example,

> Process data would continue to be corrected by the Honeywell [data capture] machines, transferred to the VAX system [the DEC computers on which RIS was to run] at frequent intervals, reconciled and condensed into hourly figures. These could include spot, average, high and low values. Data could be stored on-line for perhaps as long as a year to permit historical analysis, and thereafter archived [3].

Thus it is important to note that RIS was only to provide a certain sort of view of the operations of the refinery, a view predicated on the concerns of oil management. For example, as we noted above, RIS was seen as a system that could help process controllers but it was to be distinctly separate from the process control system. The same could be said of oil accounting. Accordingly, the focus on oil management systems outlined earlier was steadfastly maintained.

> Although some data transfer between the oil management system and the administrative and plant management systems may be necessary, our view is that the volume of data to be transferred is insufficient to justify the creation of an integrated overall refinery database [3].

As we noted above, the Strategy Study Team did engage in discussions with head office personnel about the commercial links between the head office and the refinery. However recommendations in this area were limited due to the progression of another project that sought to specifically deal with this issue. The brevity of this section of the Strategy Study allows its quotation in full and draws attention to an important difference in the development of refinery systems between Grangemouth and Rotterdam.

> There is today no equivalent of the Rotterdam [SIS] system, which would provide the supply function in head office with current stocks, production estimates, and actual movements, and the refinery with nominations and current prices for modelling, blending, and value added calculations.
>
> BP Oil is now actively considering the requirements for a commercial information system (OSCA) [Oil Stock Control and Accounting System] with an interface to the refinery internal systems. There is no doubt that benefits to the supply/manufacturing function, such as better trading decisions and their impact on the refinery operation, will arise from the implementation of such a system [3].

The development of OSCA was approved by BPO and underway by the time the Grangemouth RIS Project had moved on to the feasibility study stage.

Finally, the Strategy Study Team briefly addressed the perceived inadequacy in computer knowledge at the refinery. Although the ORACLE based system was to be designed to be relatively easy to use the study recognised that for the effective utilisation of even such user-friendly systems an improvement in the level of computer support available at the refinery would be required.

> The systems proposed represent a significant increase in scope and complexity compared with the present data processing environment at Grangemouth Refinery, and there can be no doubt that enhanced skills would be required in the data processing support group [3].

With these proposals in mind the Strategy Study Team briefly considered a development path for Grangemouth. They noted that delivery of the proposed systems was likely to take several years and although some of the individual sub-systems suggested could have benefits on their own...

> It is important to appreciate that...the full potential can only be realised by the integration of all the elements [3].

Whilst proffering some ideas on the sequencing of the developments that they proposed the Strategy Study Team were keen to point out that...

> A more detailed study is clearly necessary to undertake an outline system design with a carefully considered development path [3].

The team concluded that their proposals for an integrated system would cost approximately $4.795 million and achieve benefits of approximately $4.15 million per annum [3]. The costs were obviously minimised by the availability of Rotterdam RIS software "free of cost". Curiously, for a project which could be expected to extend over a number of years and whose returns would be largely dependent on future oil prices, predicted benefits, given in terms of cents per barrel or dollars per tonne, seemed to be based upon only one oil price value. One might have expected a number of possible price scenarios to be explored in the cost/benefits section of the document.

The Strategy Study Team recommended the..

> ...formation of a system design study team (4 people, 4-6 months) to provide a more detailed definition of requirements and the development path, and a more complete assessment of the costs and benefits [3].

On the basis of the figures provided by the Strategy Study Team the system looked likely to provide significant benefits and consequently a System Design Team was indeed set up. They submitted the first stage of their feasibility study for the RIS Project in September 1988. We now go on to consider how their recommendations led to the RIS system that was actually developed at the refinery.

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CHAPTER SIX

THE GRANGEMOUTH RIS PROJECT FEASIBILITY STUDY

Introduction

The Grangemouth RIS Feasibility Study was undertaken by a System Design Team comprised of three BP employees and one member of Scicon's Energy Division. At the time of the completion of the Stage 1 Report in September 1988, Scicon was still a subsidiary of the BP organisation. Two of the BP members of the team were Grangemouth refinery staff: one from the Production Department, the other from the refinery's Technical Department. The third BP member of the team came from BP International's Information Systems Services group [1].

The team agreed "..a schedule for a five stage approach to the Study" with the Steering Committee (more about them later) responsible for overseeing the project's progress [1]. The Feasibility Study sought to utilise the Scicon approach to "Defining an Information Systems Strategy" [2] as an "adaptable" [1] starting point for their deliberations on the potential for RIS at Grangemouth. The Scicon approach "..recommends the splitting of an IS Strategy Study into the following three phases:

Phase 1 - Business Requirements Study
Phase 2 - Systems Study
Phase 3 - Strategic Plan Development [2].

The approach was seen, by the System Design Team to "..be more suitable for completely new computer projects than for a project such as Grangemouth RIS which will link and build upon existing systems" [1]. They also pointed to weaknesses in terms of the approach's facilities for the evaluation of candidate solutions and in terms of its lack of provision of milestones against which progress could be measured, monitored, and corrected [1]. The team felt, however, that with the inclusion of two additional stages in the study it would be possible "..to overcome these deficiencies" [1]. Thus, the study was to consist "..of the following five stages:

> Stage 1 - Plant Familiarisation and Documentation of Existing Systems
> Stage 2 - Business Requirements Study
> Stage 3 - Evaluate Candidate Solutions
> Stage 4 - Develop Target Architecture
> Stage 5 - Strategic Plan Development [1].

The five stage approach was seen to "..provide opportunities for the identification of early implementation possibilities" [1]. Although the System Design Team were nominally in the business of providing a "Feasibility" Study for RIS at Grangemouth, as we noted in the previous section, BP Oil were keen to emulate the perceived "competitive edge" [3] derived from the first RIS system at Rotterdam in its other major refineries worldwide. This strategic aim, coupled with the positive response to the idea of RIS at Grangemouth provided by the 1987 Strategy Study [4] meant that the provision of some form of RIS type system at Grangemouth was virtually a foregone conclusion. It was really only the specifics of the Grangemouth instantiation of RIS that were still up for grabs in September 1988.

Each stage of the "Feasibility Study" was to "...culminate in a formal report (i.e. four interim reports and one final) which [could] be reviewed by the the end users and the steering group" [1].

Justifying and Ratifying RIS at Grangemouth

The Role of the Steering Committee

The types of "weaknesses" and "deficiencies" pointed to by the System Design Team in the Scicon approach are suggestive of the key role that firm management was seen to play in the realisation of a successful and cost effective RIS at Grangemouth. It is notoriously difficult to maintain and meet original specifications and costings in the development of large scale information systems. Active project management, at a number of levels, was perceived to be the solution needed to alleviate these problems, although there was recognition, on the part of the Steering Committee that this is easier said than done. As one member of the Grangemouth Committee pointed out:

> ...it is very very difficult to cost information systems, it's largely a question of faith, and it's even harder to measure benefits. But you can benefit the thing overall, you can probably bench mark the site overall, but to actually split it down into components, which is what you're trying to do when you're justifying a system is very difficult... I have a rough idea what the function costs [and] what the benefits ought to be, and it's a question of using judgement as to whether you believe that or not [5].

Ratification of Grangemouth RIS was to be dependent on a number of justificatory procedures within a number of fora within the BP Oil Group.

> Within the Europe organisation, essentially you build it into your business plan. Assuming it's in your business plan, then that sort of money can be handled within the European organisation. But it has to be endorsed by what we call the Business Development Unit in London and that's corporate within BP Oil. So if it's included in the business plan then the sanction is within Europe, but endorsement is required from the BDU. For a project of that size it would be second in command, or something like that, in Europe who would take the decision [5].

Even after ratification at that level, strict control was to be maintained by the Steering Committee. At Grangemouth, they met...

> ...every few months. I mean these meetings can be stretched if there's not a lot going on, then obviously the date can be moved out a bit. If there's a lot going on that needs some sort of endorsement from the [Steering] Committee they'll be much more frequent. What the project does is report on it's progress against the technical targets and the financial targets, and the project's usually split into phases, so you can measure your expenditure against your phase allocation. So.. they've been allocated a fund [and].. the refinery manager will control the release of those funds to ensure that they're being spent in the right way. I think there is a danger with systems projects, as we've discovered from failures in the past, not in this kind of area but just systems projects generally, because they're not that well defined when you set off. The danger is that you can go off at tangents and you can overspend dramatically [5].

The successful implementation of the first RIS at Rotterdam was seen to derive primarily from strict application of sound project management practices and BP were keen to emulate this facet of the Rotterdam RIS at subsequent sites. Issues concerning commonality of core software, described in the first part of the RIS story, were also seen to be key here.

> ..I think the RIS project at Rotterdam, which was $24 million worth, was one of the first IS projects to come in on time and within budget and actually do what it was meant to do. That's not to say that there weren't things that needed sorting out, but to all intents and purposes the project was a success. Now if you look at the Grangemouth situation, even though [they may pick] up a lot of software from elsewhere, there are things which [will be] relevant to Grangemouth that [wouldn't be] relevant to other refineries and there [will be] bits of the system they don't particularly like and they wish to redesign. So the danger is that whilst, you know, we can support these kinds of developments, what we don't want them doing is going completely berserk. What these project boards serve to do is to ensure that they are making progress on developing bits, but without losing sight of some sort of finishing date and the amount of funds they've got. The other possibility is of course if you find yourself in a hole then you could possibly delegate that to a research centre or some other.. centrally funded part of the organisation. Particularly if it's a big problem and/or likely to

be a common problem. Another possibility.., of course, is that because it's often advantageous to implement these things within a project like this (you stand a much better chance than doing it remotely) then you might [get] central funding so you have additional funds coming in from the centre, for the benefit of everybody [5].

Subsequent events at Rotterdam and Bulwer meant that for development staff at Grangemouth these strictures were particularly acute and they became more acute as the project went on. We have already alluded to the problems that began to emerge at Bulwer as the second RIS implementation progressed. However, before completion of the Grangemouth system, problems started to emerge at Rotterdam. These problems were admittedly more to do with issues external to the development of RIS, but they did come to impinge on the justificatory potential of subsequent RIS implementations. The perceived initial success of the Rotterdam RIS led one member of the Grangemouth Steering Committee to remark that...

I must admit sympathy [with the System Design Team] in the sense that I realise how difficult it is to pinpoint down from some of these things and my personal opinion is that we should've, having audited the first system at Rotterdam, which provided better benefits than we'd envisaged, ..then accepted the principle, accepted the fact, that they did generate benefits and not worry about costing and benefiting. Well, of course you'll cost and benefit, but not being so obsessed with the benefits of future systems [5].

One would perhaps have expected ratification of subsequent RIS projects to become easier following the extremely favourable results of the initial Rotterdam audit. However, instead they soon became...

...more difficult. But that's rather an unfortunate circumstance really that we find ourselves in. Shortly after the RIS system went into Rotterdam they formed a joint venture in Rotterdam and the system wasn't designed for a joint venture and therefore basically wasn't used. The second RIS implementation in Bulwer Island Refinery down in Australia.. overstretched themselves.. in terms of the production system design and because of that they basically failed to meet their goals and are still trying to implement the system... So because of those failures, if you like, or the perception of failure, management are very reluctant to spend money on RIS projects and we had to fight quite hard to get the Grangemouth project through and each time one of these things comes up we're in exactly the same situation where you have to reconvince people [5].

These problems were not apparent, or at least they were not formally discussed in 1988, at the time of the Feasibility Study. Rotterdam had still not completed its RIS implementation and the Bulwer system was still in the early development stages. There was no mention of the Rotterdam joint venture in any of the five volumes of the Grangemouth Feasibility Study. The Bulwer Island system is first mentioned in the Stage 3 report, although no performance problems are suggested. The System Design Team did, however, express a desire to liaise closely with Bulwer development staff to ensure the early identification of any problems that did emerge. These issues were to become more important as the Grangemouth development proceeded. As the preceding quote suggests, the inevitability of RIS at Grangemouth that was so pronounced in the Stage 1 Feasibility Study Report, was rather rapidly diluted, and action was required on the part of the System Design Team to convince the Steering Committee that the promised benefits would indeed be delivered.

One of the key problems that emerged at Rotterdam, notwithstanding the implications of the joint venture, was the organisational realisation of the benefits expected to accrue from the technical wizzardry that was RIS.

> ...I think the key thing is having solved the technical problems and putting the systems in [there] you then have a secondary problem in that if you don't use the RIS system and people, the

> users, aren't committed to it, you don't get the benefits. And that is one of the key problems that we're facing really.., bringing the users along with the implementation of the system and ensuring that they use it after the event... Having seen the lack of enthusiasm, if you like, certainly in the Rotterdam refinery, I think it is important that we try and boost this now [5].

We will go on to consider, in detail, how the realisation of benefits was managed at Grangemouth shortly. Before doing so however, it is important to note that the "question of faith" was still important for all concerned on both sides of the development process. Those monitoring and ratifying the decisions of the System Design Team had to have faith in realisability of the somewhat ephemeral benefits envisaged by the Team. However, the faith of the System Design Team itself, and the active exhibition of that faith were also of paramount importance. In the absence of strong, precise, "objective", numerical justifications the Steering Committee had to look to other clues in order to allow them to assess the likelihood of the realisation of the System Design Team's plans.

> ...if you don't believe in it then you can't sell it to your management when you present the case [5].

From Feasibility Study to Final Specification

Changes Envisaged in the Feasibility Study

By the time the Final Report [6] of the Grangemouth Feasibility Study was completed in February 1989, a number of significant changes to the recommendations of the 1987 Strategy Study[4] had been suggested and agreed. Indeed, by the time the Stage 1 Report was published, doubts were being expressed by the System Design Team over the applicability of the Head Office LP model for the Grangemouth Production Department [1]. The Strategy Study had recommended the replacement of the refinery's Sciconic LP with the Head Office model, but the authors of the Stage 1 Feasibility Study felt "..that this should be considered further before implementing the change, and it will be reviewed as part of the study" [1].

The System design team were not, however, keen to retain the Sciconic LP at the refinery. Whilst it did provide "..a quick means to define the optimum mode of operation for the Refinery in line with processing capability, market prices, and requirements" [1] it had other disadvantages that extended beyond its lack of consistency with the Head Office LP model. The Sciconic LP was seen to be "poorly documented", time consuming to use and update, and lacking a recursive facility that would allow simpler representations of process units and, perhaps more importantly, the provision of <u>definitive</u> solutions. It was "not particularly user friendly", it required expert production and computing knowledge to interpret solutions and to update the database, and it could "suggest benefits which are not in practice attainable" [1]. Some similar concerns were expressed about the suitability of BPRSS for RIS, particularly with regard to the need for both practical refining and computer programming experience. These inadequacies were described with reference to their commercial consequences. Timely, accurate information on production potential as well as production commitments were seen to be required.

> The benefits of operating with lower stocks depends to a large extent on accurate forecasting not only of production but also of offtake...Without accurate information in this area there is a risk of stock-out if stock levels are allowed to operate at a very low level. Maintaining sufficient buffer stocks to prevent this both ties up capital and reduces operating flexibility and can possibly result in lost sales opportunities [1].

Against this backdrop of commercial problems with the proposals for RIS LP modelling provided by the Strategy Study, the authors of the Stage 1 Feasibility Report offered no implementation proposals of their own. The remit of this part of the study, that is, "Plant Familiarisation and Documentation of Existing Systems", allowed them to defer their decision. They may have been aware of other candidate solutions emerging in the BP world, that were not sufficiently respectable to warrant consideration in September 1988. The team seemed happier to take a "wait and see" approach to the problem.

Although changes were beginning to be made to the proposed RIS development path, they were made against the background of progress on the Oil Stock Control and Accounting (OSCA) and PIP projects. The provision of stock information to Head Office and the instrumentation of process units were seen as essential pre-requisites for RIS by both the authors of the Strategy Study and the System Design Team. "Implementation of the main part of OSCA [was] due to be completed by the end of 1989" [1] and "The Process Implementation Project [was] nearing completion at the time of writing" [1].

During the "Business Requirements Study" [7] some 40 Grangemouth and BP Oil employees were interviewed by the System Design Team. They found that "Historically, computer systems have been imposed on the Grangemouth Refinery, often from outside, without adequate user involvement at the analysis stage" [7] and that "Training in awareness of modern information technology is urgently required" [7]. These findings are consistent with the concerns raised by the Strategy Study and were seen by the System Design Team as further evidence of the lack of "management control over the development of new systems; there is no strategy" [7]. These issues were seen to be fundamental and led the System Design Team "to recommend that a separate study should be implemented to look at the overall refinery computer systems' requirements, identify the weaknesses in current systems, and develop a plan for improving them" [7] Thus, again we see a conception within BP of effective management as the cornerstone of successful utilisation of IT. Action was also required to bring "up the level of IT awareness of Grangemouth personnel in order that the maximum benefits of any RIS implementation may be obtained" [7]. A key problem here was the narrow view taken by prospective users of the benefits of IT. Grangemouth employees saw "computer facilities.. only as tools to help them perform their own jobs better" [7]. The commercial orientation of RIS demanded the provision of "hard financial benefits of their having better Refinery information" [7] and this sort of appreciation was to be a key aim of the improved IT awareness training proposed by the System Design Team.

Following a somewhat similar vein, the Team also recommended the introduction of "an effective electronic mail system" [emphasis in original] [7]. RIS was seen as a leap forward into the information age and an information based organisation was needed to support it. The desire for electronic mail may be seen as another facet of this trajectory.

In the Stage 2 Report possible directions for the development of RIS were presented against the backdrop of BP Oil's business strategy for the Grangemouth refinery. In essence, BP Oil was "to remain a national marketer supported by refining operations at Grangemouth" [7]. It is important to note here that BP's UK market was not, and was not expected to be, supplied by Grangemouth production alone. Exchanges and purchased products were to continue to play a major role.

> The company's market demand is met primarily from 7 mta [million tons per annum] product refined at Grangemouth together with a processing deal at Texaco's Pembroke refinery, which yields 1.7 mta.
>
> Allowing for about 0.5 mt refinery output as LDF sold to BPCL [BP Chemical Ltd], the combined refined product from Grangemouth and Pembroke is expected to fall about 2 mt short of BPO's market demand in 1993 [7].

IT and systems policy was intended to consistent with, and supportive of, this overall business strategy. For BP Oil's manufacturing and supply operations key critical success factors were defined as:

> understanding demand, by location and by refinery - linked to a knowledge of stocks and offtakes.
>
> knowing the technical performance of the refinery
>
> planning the short term optimisation of trading / refinery operation / modal movement / exchanges [7].

The perceived importance of adequate information for the achievement of these objectives is self evident. The System Design Team invoked BP Oil's business strategy on Information Technology and Systems to justify their deliberations on RIS at Grangemouth. This suggested that IT investment should be directed towards..

> achieving a balanced portfolio of applications between ongoing operation of a low cost base set of systems linked with a controlled use of low cost, quickly developed blue skies expert systems which will provide a competitive edge.
>
> We note that not all expert systems are quickly developed. We interpret the statement to mean that there is a corporate will to try systems which use leading-edge technology. The development of these systems must be carefully monitored [emphasis in original] [7].

We can see here more evidence of the tension within BP between playing it safe with technology and taking risks that may lead to a competitive advantage. Moreover, we can also see again the importance attributed to effective project management in the resolution of this conflict. The System Design Team attempted to clarify the position by raising questions about the organisation's broad "technology positioning" policy. However, the way in which the question was posed does much to reveal the preferences of the team.

> does [the organisation] wish to remain with the ageing technology it has lived with for years, accepting ever-increasing software maintenance costs as the price to pay for its investment in established software?
>
> would it prefer to make a step change to the technology that is available today, paying no attention to what is around the corner?
>
> as a matter of principle, is it policy to adopt "blue skies" technology wherever possible, accepting the higher risks of this policy against the potential gains of increasing its leading edge over the competition [7].

Clearly the technological specialists who made up the System Design Team favoured the "blue skies" approach, with the essential proviso of strong project management. In fact, it is interesting to note that the third option appeared in the Stage 2 report without a question mark, as it is reproduced above. Whilst this may have been merely an error on the part of a typist, it may also reflect a "Freudian Slip" on the authors' behalf.

In the next section we examine the influence of this approach on the choice of Linear Programming System for the Grangemouth RIS.

Changes to the Proposed Linear Programming System

In the Stage 2 Report we find the first mention of the MIMI/LP package that was used for production planning and scheduling at the Bulwer Island refinery. However, no mention is made of the Bulwer System.

- Although MIMI is new to BP it is licensed by several major companies, including Amoco, Shell, Sun, Du Pont and Chrysler [7].

As we noted in the section considering Bulwer's implementation, MIMI stands for "Manager for Interactive Modelling Interfaces". It is described in the Stage 2 Report as an "LP Option" along with the refinery's Sciconic LP and the Head Office modelling system. The team maintained their earlier reservations about the latter two whilst the MIMI system is described as "a flexible interactive front-end for modelling applications.. It provides an integrated framework for bridging applications programs, databases and distributed computers with a common interface", whilst "the /LP module provides the capability to generate, solve and report solutions to LP problems" [7]. No disadvantages are identified and a number of advantages are described. These include the system's flexibility and "its ability to interface with a data base and with other application programs, as well as its potentially powerful set-up and reporting facilities" [7].

The benefits of additional complementary modules are also described, despite the fact that these were still under development by the manufacturer at the time of writing. Additional modules were to "include: MIMI/G, an interactive graphics module; MIMI/E, an expert systems shell; and MIMI/S, a planning and scheduling module" [7]. The compatibility of the MIMI/LP with the long term aims of BP Oil in general, and the System Design Team in particular, seemed to make it a natural choice. The presentation of alternatives in the Stage 2 Report made the adoption of any another solution extremely unlikely.

Great enthusiasm for the development of expert systems at Grangemouth is apparent in the Stage 2 Report and the expected development of an expert systems shell for MIMI must have served to make it all the more attractive. The Team went so far as to suggest "at least three areas where Expert Systems technology could be applied fruitfully.. in the Grangemouth application" [7]. "Blue skies" solutions seemed to be the order of the day.

Similarities with the Strategy Study Recommendations

Although changes in the proposed LP system seemed likely, the commitment to an ORACLE based system, made in the 1987 Strategy Study was maintained. "ORACLE is in use in other BP refineries, and is a BP strategic project" [7].

Significant attention was also devoted to activities designed to improve the amount and accuracy of the information collected on the refinery's operations and conditions. Reiterating the Strategy Study the System Design Team claimed that significant commercial benefits were derivable from improvements in this area. Removal of uncertainty in plant and operations data was not only a pre-requisite for the establishment of systems designed to build a commercial advantage out of manipulation of that data. It also provided benefits directly through the minimisation of unaccountable losses, removal of double guessing, and through reductions of margins of error and hence requirements for "buffering". Those negotiating with customs officials over appropriate duty payments were also provided with better resources by these improvements. The improved quality of information was expected to provide greater accuracy in the calculation of duty requirements and hence lower tax bills [7]. PIP and other similar smaller scale projects to re-instrument areas of the refinery were thus seen to be of vital importance.

As we noted above, OSCA was also progressing at full speed. Although outwith the RIS project, the system was important for the sort of commercial focus the company was seeking through, amongst other things, its IT policy. No significant changes to the proposed development of OSCA were suggested in the Stage 2 Report beyond noting problems with dependence upon the program that was to serve as an interface between OSCA and refinery based systems such as RIS. The Team did not suggest an alternative interface, presumably since OSCA lay outside their terms of reference.

New Benefits, Old Costs

The System Design Team estimated that the total annual benefit of the RIS they describe in the Stage 2 Report would be $3 005 000, assuming an exchange rate of £1 = $1.7 [7]. "This compares with the figure of $3 227 000 (excluding benefits derived from better process models) claimed by [the 1987 Strategy Study]" [7]. The problem of quantification of benefits was ever apparent, for example, although "it was universally acknowledged that better information exchange between" the refinery and Head Office "would significantly improve the company's ability to grasp evanescent commercial opportunities. This was admitted..to be almost impossible to quantify" [7].

The calculation of benefits was not very detailed, but it did demonstrate the potential for significant commercial improvements. The exact figure is unimportant, the project still looked commercially viable. Indeed the exact figures were so unimportant that "the costs of achieving the forgoing benefits have not yet been estimated: this is a task for later RIS study stages" [7].

The Stage 3 Report [8] opens with an announcement of the Steering Committee's acceptance of the development of "an integrated RIS system with a relational database at its core..there was no feasible or desirable alternative" [8]. The remaining Feasibility Study Reports thus sought to recommend a develop and implementation path that was consistent with these objectives.

Specifying a Development Path for RIS at Grangemouth

The ratification of the System Design Team's preferred framework for RIS at Grangemouth was seen to be dependent on a number of factors: the analysis of Business Requirements in the Stage 2 Report pointed to "a highly integrated planning system"; technical considerations suggested "that a properly designed relational database [was] the only feasible solution to link all the necessary modules in a manageable and maintainable way; the approach represented "good, modern practice in the computer industry at large"; support for RIS from the BP centre was still strong - "it is seen as the only way forward"; and staff at Rotterdam were "convinced that real benefits" were already being derived from their original RIS which was, at the time, "not yet fully commissioned" [8].

The System Design Team were keen to emulate Rotterdam's success at Grangemouth. There was a high degree of commonality perceived between Rotterdam's and Grangemouth's business requirements, and thus, the team felt that there was "a large amount of software that can be taken from Rotterdam to form the foundation of a Grangemouth system" [8]. However, given the technical complexity of the task before them, the

Team suggested that the expertise of people with experience of the Rotterdam implementation could prove invaluable. In order to exploit this potential boost, the team re-scheduled some of their activities. The Stage 3 Report included:

a recommended approach for implementation of RIS

a development plan for start of the implementation early 1989

preliminary cost estimates for the 1989 development work [8].

These activities were originally to be covered by the Stage 4 and 5 Reports. The benefits envisaged from proceeding with the implementation in 1989 included "the opportunity to transfer key personnel from the successful Rotterdam project to Grangemouth; this window of opportunity" was expected to close in early 1989 [8]. Moreover, early implementation was seen to enable BP to "maintain their competitive edge in RIS systems" [8]. The detailed Systems Analysis required at this stage was also seen to provide benefits. These were to arise from the provision of "early, valuable information to allow sound decisions to be made to improve the flow of information throughout the refinery - not just within RIS" [8].

The development approach recommended involved the setting up of..

a small team working on systems analysis, prototyping and development of detailed specifications in parallel with installation of the database and some of the Rotterdam software [8].

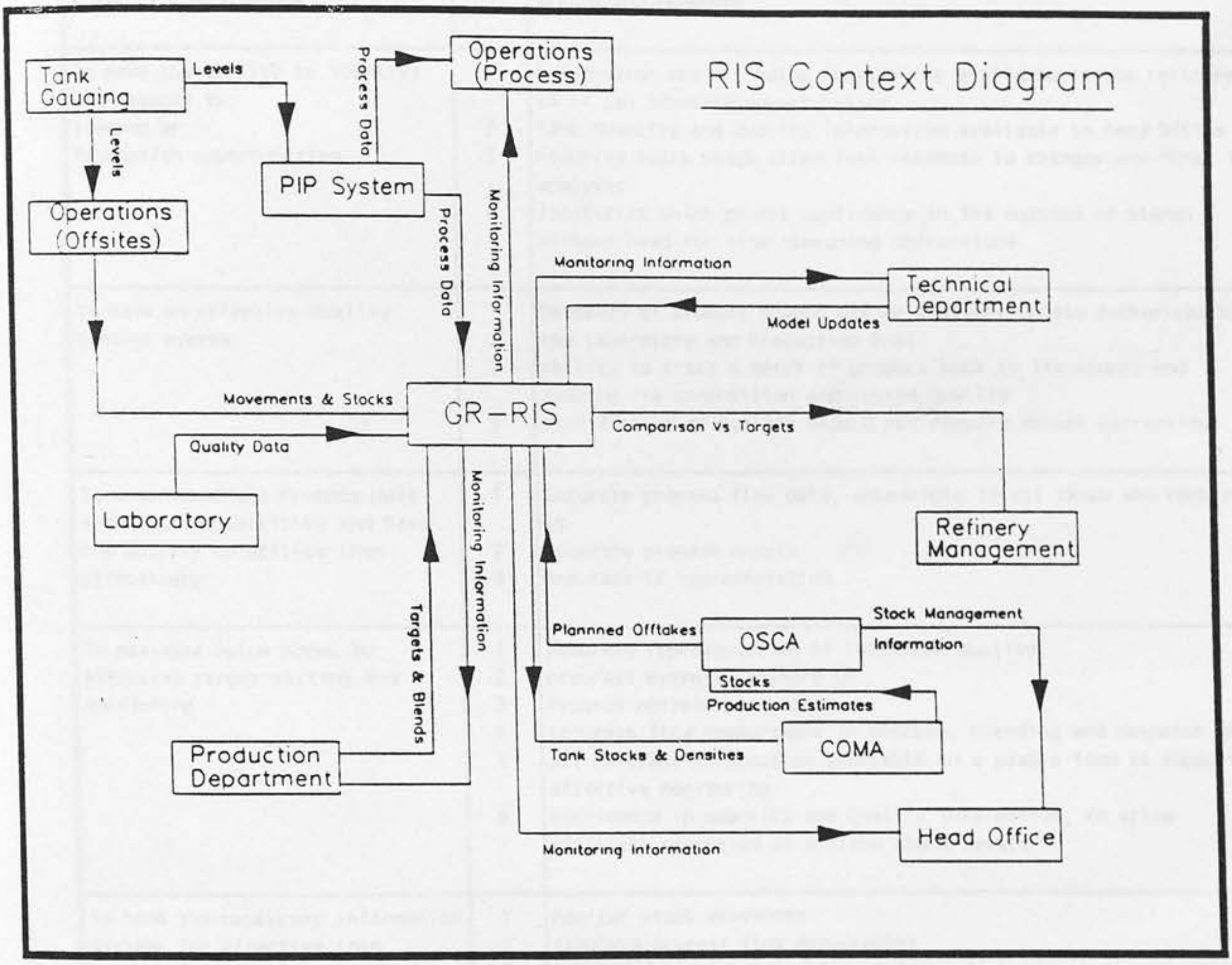
Such an approach was seen to be consistent with a total project implementation timescale of approximately two years. Thus, the full system would be installed by early 1991.

The general approach taken in the design of the various subsystems is to retain existing software which is good and meets our requirements, or where there is no better economic alternative. Purchase of new software has been recommended where the existing systems are inadequate, where the software is a crucial part of the integrated system, and where the potential benefits are high [8].

As we noted earlier, in-house Rotterdam software was obtainable "cost free" although costs of modifications to this software to meet the exigencies of the Grangemouth situation were to be borne by the project. However, a number of recommendations were made for the purchase of proprietary packages and systems.

The new software recommended is the VG Laboratory System (used in Rotterdam RIS), the MIMI system which has integrated LP, expert system, and scheduling modules (being implemented at Bulwer Island RIS), and MTTS Movement Tank Tracking System for identification, logging and graphical display movements (being implemented at Vohburg and probably at Gothenburg and Bulwer Island) [8].
[VG is the name of the supplier of the Laboratory System]

Given the agreement between the System Design Team and the Steering Committee over an approach to the development of RIS, the former felt able to provide a framework describing the context in which the system was expected to function at Grangemouth in their Stage 3 Report. This framework is reproduced overleaf. The system to be developed sought to meet a series of agreed business requirements, ratified by the Steering Committee. The various subsystems to be developed and their integration were to be driven by these requirements. The business requirements and the systems requirements thought to be their consequences are also reproduced [8].


RIS Context Diagram
Tank Gauging
Levels
Levels
Process Data
Operations (Process)
PIP System
Operations (Offsites)
Process Data
Monitoring Information
Monitoring Information
Technical Department
Model Updates
Movements & Stocks
GR-RIS
Comparison Vs Targets
Quality Data
Laboratory
Monitoring Information
Refinery Management
Targets & Blends
Plannned Offtakes
OSCA
Stock Management
Information
Stocks
Production Estimates
Tank Stocks & Densities
COMA
Production Department
Head Office
Monitoring Information

BUSINESS REQUIREMENTS		SYSTEM REQUIREMENTS
To have the ability to identify and respond to Trading or Production opportunities	1	Information about trading flexibility available to the refinery so it can identify opportunities
	2	Tank quantity and quality information available to Head Office
	3	Planning tools which allow fast response to changes and "What if" analyses
	4	Facilities which permit confidence in the outcome of blends without need for time-consuming corrections
To have an effective Quality Control system	1	Despatch of product should not be possible unless authorised by the Laboratory and Production Dept
	2	Ability to trace a batch of product back to its source and examine its composition and tested quality
	3	Certificates of Quality should not require manual corrections
To understand the Process Unit technical capabilities and have the ability to utilise them effectively	1	Accurate process flow data, accessible to all those who require it
	2	Accurate process models
	3	Accurate LP representation
To maximise value added by effective target setting and monitoring	1	Accurate representation of feedstock quality
	2	Accurate overall refinery LP
	3	Process optimisation models
	4	Accurate flow measurement in process, blending and despatch areas
	5	All relevant information available in a usable form to support effective monitoring
	6	Confidence in quantity and quality information, to allow efficient operation at minimum stock levels
To have the necessary information systems for effective loss management	1	Monitor stock movements
	2	Accurate process flow measurement
	3	Information to support BP's position in cases of disagreement with HMC&E over duty liability
To create a broad based understanding of refinery operations and strategic requirements	1	Ability to distribute information to those who require it to carry out their job to the highest standard

Recommendations for Implementation of the Grangemouth RIS

In this section we consider in more detail the approach to development and implementation of the Grangemouth RIS set out in the Stage 3 Feasibility Study Report.

Production Planning and Scheduling

The initial recommendations on the choice of LP systems for RIS at Grangemouth, set out in the 1987 Strategy Study [4], were formally rejected in the Stage 3 Report. The System Design Team favoured the adoption of the MIMI/LP system that was being implemented at Bulwer Island. They, in line with the 1987 Strategy Study, saw no future for the Sciconic LP, but they did feel able to recommend the use of the Head Office LP model at Grangemouth "as an interim solution and as a way of getting a model that both the refinery and Head Office have confidence in" [8]. This temporary respite for the idea of using Head Office model at Grangemouth was seen as worthwhile "only..if the model formulation is improved at the same time" [8]. MIMI was now undoubtedly seen as the solution in waiting:

> MIMI looks like a much better solution both in the short term, and more important, as a longer term strategic tool for refinery planning. Provided Bulwer Island do not give unexpected unfavourable feed-back this is the route recommended for the Grangemouth RIS system [8].

The adoption of MIMI elsewhere in the BP group had important implications for its acceptability. Improvements to the Sciconic system would have resulted in Grangemouth having another "individually tailored solution with all the maintenance and development problems that entails. Better to follow the route chosen by one of the other RIS implementations, so that knowledge and software can be shared" [8]. As we noted earlier, the expert systems potential of the MIMI solution made it all the more attractive to the Design Team. This module, when available, "could be used to make the LP set-up and solution interpretation easier and more user friendly" [8]. However, the benefits of MIMI did not come cost free, either economically or organisationally:

> The MIMI system is by its very nature flexible, and the problems are more likely to be associated with controlling the flexibility to get the best out of it. The experience of Bulwer Island refinery will be valuable here [8].

Hence, the team suggested the immediate upgrading of the Head Office LP for use at the refinery and the gleaning of information from Bulwer, before MIMI's suppliers were asked to create an application for Grangemouth, "with as much commonality with Bulwer Island as is possible or desirable" [8].

With regard to scheduling, the team recommended improvements to the accuracy of BPRSS, although they noted that the system "would not be a particularly useful operational tool until the data input is automated" [8]. Thus, their plan was broadly in line with that suggested in 1987 [4]. However, there were hints about extending MIMI to cover scheduling of refinery processes. Although it was felt that BPRSS would give better information than the LP, it was suggested that "this option should be reviewed later" [8]. The team also suggested that the off-line plant models, which although in existence were not widely used, should be transferred to the VAX platform on which RIS was to run "as soon as live process data is captured in the RIS database" [8]. The importance of improvements to the Head Office LP as a paving step for the future implementation of MIMI were also emphasised in the scheduling context.

Improvements to the Information on which RIS was to Depend

As well as applauding the success of the PIP, albeit with reservations about its future hardware platform, the Stage 3 Report detailed plans for the introduction of a Flow Measurement Uncertainty Reduction (FMUR) subsystem as part of RIS.

> The availability of uncertainty-reduced flow measurements to users and to other computer systems will enable a clearer picture of actual flow conditions to be obtained and will help the achievement of production goals [8].

The FMUR system was to take plant measurements transmitted via the PIP system and produce reconciled flow measurements. A measurement's uncertainty was to be determined using a hierarchy of procedures descending from recent physical recalibrations of meters, through numerical calculations, down to rule of thumb estimates with the "best" measure of uncertainty being used in each case. Once all individual uncertainties had been defined, a mass balance reconciliation was to be performed that sought to apportion discrepancies in mass balance in the physical refinery system "reasonably across the meters" [8]. That is, the larger the flow uncertainty of a meter, the greater the proportion of mass balance discrepancy attributed to it.

The team also made recommendations for changes to the physical refinery system, not just its representation within RIS, where these changes were seen to be important for realisation of RIS's potential commercial benefits. In particular, updates were proposed for the machinery used in the blending of, and the introduction of additives to, refinery products. Achievement of the refinery's business requirements was seen to depend not only on accurate information but also on the possibility of predictable results of interventions and normal operations. It was no use having information on how to bring a product up to spec., if the tools to physically bring about the change were too imprecise to implement the desired change successfully or with requisite certainty. The commercial benefits of RIS did not depend solely on the software used and the hardware platform supporting it. The physical refinery had to be physically controllable at a similar level of resolution to that provided by RIS.

Satisfying the Information Needs of the Head Office Users

The Stage 3 Report provided a more detailed assessment of the information needs of Head Office users along with some ideas on how these needs were to be met.

> The main requirements for Head Office are for information about current and planned refinery operations, which will involve transmission of data via OSCA, transmission of fixed reports, and flexible query facilities to access data from the data base [8].

These requirements were derived from the business objectives of those elements of the corporate organisation responsible for the refinery -

Head Office interface. These objectives included an "ability to identify and respond to Trading or Production opportunities" coupled with an understanding of "the technical capabilities of the process units" [8]. Such an understanding was seen to be required for BP Oil's effective utilisation of the Grangemouth plant. RIS could not alone provide the entire solution.

> The first of these objectives implies a two way flow of information between Head Office and the refinery. A RIS system will certainly satisfy the requirements for information flow from the refinery to Head Office, but it is probably not the most effective tool for distributing the necessary information about trading flexibility in the other direction. An electronic mail or informal bulletin system is probably a better solution [8].

The proposed electronic mail system connecting Head Office and refinery personnel may be seen as an extension of the desire for such a system <u>within</u> the refinery, expressed by the System Design Team in the Stage 1 Report. Indeed, considering the good progress being made on the implementation of OSCA and the <u>refinery based</u> nature of RIS...

> No unique facilities [were] envisaged for Head Office users. Their requirements should be satisfied by a subset of the facilities provided for refinery users [8].

<u>Positioning the System Designers and Programmers:</u>

<u>Outlining the General Approach</u>

As the System Design Team were keen to emphasise...

> The subsystems described previously..form part of an integrated Refinery Information System. Sight of this crucial fact must not be lost during the design and development of RIS. The information supplied by each subsystem must be available to any of the users of RIS (if their password privileges allow) through a seamless man-machine interface [8].

In order to ensure that the programmers and designers did not "lose sight" of their overriding aim the System Design Team provided outline specifications of general facilities common to all of the components of RIS. These "outline specifications" varied in prescriptive strength although they all sought to ensure the consistency seen to be essential for "an integrated Refinery Information System". Requirements for facilities such as terminals and workstations were already largely determined by previous choices and could thus be specified concretely. For example, with regard to VDU terminals, the Team suggested that "Where non-DEC devices are used, there must be no operational difference (screen colour set, keyboard layout, etc.) between them and the equivalent DEC device [8]. Other specifications, whilst not definitive, still pointed to the need for consistency. Some choices over exactly what this consistent form should be were left for later. For example, when considering the coherence of information presentation the team suggested that..

> All RIS subsystems must present their information in a unified and coherent manner. Specifically, this shall include: common conventions for using colour; common error/warning message layout; common screen layout structure (head banner for orientation, body for RIS information, foot banner for errors and warnings); uniform display of decimal digits; context-dependent help facilities; field value selection lists; uniform date and time presentation, and the use of highlighting/flashing [8].

Other recommendations in a similar vein included:

> <u>Use of Graphics</u>
>
> The use of graphical means of presenting complex information is to be encouraged. To help in this, an integrated on-line graphics facility shall be provided as part of RIS.

Consistent Menu Structure

It is mandatory that a consistent menu structure and navigation feature be designed into RIS. Design guidelines for this must embrace: a system-wide menu tree; inter-screen navigation steps; a navigation help feature; inhibition of redundant function keys, and operational modes for inexperienced and for expert users.

Ad Hoc Query Facility

A facility shall exist to enable users to request the reporting of any (reasonable) selection of data in the RIS database, summarised and presented as he (sic.) wishes. For reasons of machine resource loading, this facility will only be available via a suitably trained and knowledgeable support group.

Backup, Recovery and Archive Facilities

Routine data backup and recovery shall be possible in a manner which has little or no effect on the continuous operation of RIS. Any data may be archived - once agreed with the support group - and replayed into the system for analysis.

System Security

System security features shall be provided which protect RIS at the following levels:

disaster recovery (the ability to restore the system and recover its information from backup media held off-site)

unauthorised access from outside the BP Group (accidental or malicious)

unauthorised user access to the different RIS subsystems and data areas

unauthorised data modification [8].

Thus although the man-machine interface was to be "seamless", a number of seams were to be built into, or not removed, from the machine. Considerations of machine resource loading and security provided a rationale for some restrictions on the unmediated flexibility potentially offered by an Oracle relational database system. As the previous quote about MIMI suggests, having chosen potentially flexible building blocks, the main problems for the Design Team were "likely to be associated with controlling the flexibility to get the best out of it" [8]. There is an interesting tension here between the Design Team's insistence on consistency, presumably intended to facilitate (managed) "flexible" usage, and their recommendations for passwords, "reasonableness", and support groups, presumably intended to restrict, control and monitor such usage. The lack of IT knowledge at the refinery and worries about security and system performance together provided a significant countervailing force against unmitigated flexibility. This tension existed not only between an idealised theoretical RIS and its practical realisation at Grangemouth but also between the implications of that ideal and other ideals such as managerial control that were also struggling for the Design Team's attentions.

Choosing a Systems Development Approach to Match the Requirements

> There is only one realistic development approach for the Grangemouth RIS system. This is the approach variously known as "end-user computing", "user-led computing", or - our preferred term - "Joint Application Development" (JAD) [8].

The System Design Team provided two justification for the foregoing statement:

> The first is that the "classical" systems development methodology (the generation of massive and incomprehensible requirements specifications, followed by woolly systems specifications) simply does not work. If it produces anything at all, it produces systems which are late, over-budget and which only vaguely meet the business requirements [emphasis in original].
>
> The second justification is that once the JAD approach was adopted on the Rotterdam RIS implementation, the project proceeded with startling success and is now on target for a timely and within budget delivery [8].

As we have already noted, "the RIS project at Rotterdam.. was one of the first IS projects to come in on time and actually do what it was meant to do" [5]. The System Design Team were keen that the RIS project at Grangemouth should do the same. Moreover, the JAD approach was seen to be consistent with the RIS philosophy of collecting and analysing data and information according to its commercial potential. "Knowledgeable members of the user group" were the best source of this information [8] even though, at Grangemouth, users did not seem to be particularly adept at providing "hard financial benefits of their having better Refinery information" [7]. Rather they saw "computer facilities.. only as tools to help them perform their own jobs better" [7]. Various techniques were to be used to facilitate this orientation throughout the development. These included "Business Area Analysis", "Data Modelling" and "Prototyping" [8].

Business Area Analysis "should identify all essential and beneficial information flows throughout the refinery - and also any which are redundant" [8]. This objective was to be achieved through "liaison between the systems analyst and knowledgeable members of the user group" [8]. Such an analysis should "indicate where interim improvements could be made while the target system is being constructed, in order to provide rapid benefits to the organisation" [8]. Obviously the provision of such "rapid benefits" would do no harm to the standing of the analysts, designers and programmers working on RIS at Grangemouth. Demonstrable early successes would undoubtedly facilitate co-operation with users in the achievement of future objectives.

Data Modelling demanded the arrangement of the data required by the refinery "so that they reflect business needs and not computer technology" [8]. Such a process would not only serve to emphasise the commercial orientation of RIS, it was seen as essential for other reasons:

> This process is a prerequisite of any integrated database environment because without the model a database management system would degenerate to a mere (expensive) filing system.
>
> [T]he technology of relational database to be used in RIS requires the data model as input. If data are not properly modelled, performance and integrity will suffer.
>
> [Thirdly].. data modelling results in a database structure which changes only slowly - as the business evolves. Migration of the database to different computer hardware - to take advantage of improvements in the technology - can be performed whenever appropriate while preserving the business's investment in data [8].

Prototyping of the system, the construction of "working" computerised simulations of aspects of the putative system, was to be undertaken in order "to test the principles, ensure that the system works, and obtain design feedback which enables the design to be adjusted before major commitments are made" [8]. Prototypes could be developed "cheaply and quickly" thanks to "the availability of modern tools and techniques - such as relational database and the so-called Fourth Generation Languages (4GLs)" [8].

Together these three techniques were seen to permit the joint development of applications by computer analysts and end-users. The System Design Team provide us with an idealistic view of the process in action:

> In a JAD project, a systems analyst working with an end user can create and demonstrate dialogues for database queries, report generation and manipulation of screen information. The analyst discusses an end user's needs with him (sic.) and then creates a specimen dialogue on a terminal.. Initially, questions of transaction volumes, data validation and response times are ignored.
>
> The end user is shown the dialogue and trained quickly to use it. He may then make suggestions for changes, which the analyst quickly makes. The user may add extra dialogue information, or new calculations. The analyst can encourage and stimulate him by suggesting new layouts, different ways of presenting data - such as colour coding and graphics. The user remembers forgotten items - most importantly exceptional cases, which are notoriously expensive to cater for in a live system - and the analyst implements them.
>
> Finally, agreement is reached and the prototype is frozen - or, realistically becomes subject to formal change control.. In most cases.. design work is still needed to achieve machine efficiency, security, data validation and auditability.. [T]he prototype becomes, in effect, the requirements document for the final system [8].

For this ideal to be realisable in practice the System Design Team suggested that the "communication gap" between the users and analysts be reduced as far as possible. In the view of the Team,

> This can only be accomplished by:
>
> appointing to the team analysts whose personal skills are as good as their technical skills
>
> ensuring that there is no conflict of culture between the analysts and the users
>
> making sure the users understand the techniques, terminology and tools of the analyst
>
> similarly, ensuring the analyst understands the objectives, problems and way of working of the user [8].

The first two requirements were seen to be "management issues", asserting once again the key role to be played by effective project management in the realisation of RIS. The last two requirements were to be met through "effective cross-training before the project commences" [8]. The recommendations for IT awareness training made in the Stage 2 Report were seen as satisfying the third criteria, whilst training for analysts in user concerns were "yet to be defined, since it would depend on the depth of previous refinery experience possessed by the analysts" [8]. Although such an approach was seen to put a..

> fairly heavy demand on user resources.. Investment in close user involvement in the development of RIS should be seen as an investment in building a system which is truly useful to its users and hence to the business.
>
> If a classical approach to RIS development were adopted.. user resources of this level would be consumed anyway.. in fruitless modification activities after the system had been built [8].

Curtailing JAD - Developing from the Rotterdam Base

Whilst recognising that JAD would normally demand "the development of full data models and prototypes from scratch", the System Design Team perceived sufficient functional congruity between Rotterdam's RIS and the system to be developed at Grangemouth to suggest "using the Rotterdam-developed database structure and associated software as a template around which to build [Grangemouth] RIS" [8]. The team laid out the steps involved in building upon the Rotterdam base:

- obtain VAX machine resources in Grangemouth
- obtain necessary software licences
- train users
- install the (empty) Rotterdam database at Grangemouth
- populate the empty database with suitable Grangemouth data
- transfer the Rotterdam system design to Grangemouth

build Grangemouth system prototypes

use the prototypes to develop user requirements specifications

modify the Rotterdam design to suit the Grangemouth requirements [8].

Much of the "joint development" process seen as essential for the final implementation of a usable system was considered circumventable since similar work had already been done at Rotterdam. In the light of the professed importance of JAD, the adoption of such a position by the System Design Team seems remarkable. Differences between the two refineries were perceived to be small enough to present few problems in the modification process which seems to come very late in the above development path. The availability of Rotterdam software, experience and expertise "cost free" was obviously a powerful incentive. The costs of reinventing the wheel at each RIS implementation were to be avoided by adopting the techniques and products of best practice RIS design exemplified at Rotterdam. The costs of future updates and system support would also be minimised by the maintenance, wherever possible, of common core software. Thus again we see a tension between the idealised requirements of the team's favoured approach and the exigencies of the developmental context of the Grangemouth RIS. Compromise and negotiation between a variety of physical and theoretical considerations can be seen to characterise the RIS development throughout its tranformation from rhetoric to reality.

At the time of the Feasibility Study Bulwer Island did not seem to be seen as a radical RIS Mark II. Rather it was seen as somewhat flexible replication of Rotterdam's successful approach that sought to deliver a similar product. Where improvements to the Rotterdam system had been made they would be adopted, but Rotterdam was still seen as the exemplary starting point from which future implementations would have to build. Bulwer was, at the time, just another example of this process in action, albeit an example which potentially provided a justification for minor deviations from strict adherence to the Rotterdam system. The key negotiation, or translation, was to be between Rotterdam's ready made solution and the emerging requirements of the Grangemouth situation.

Building a Team Able to Meet the Requirements

The key importance of sound project management emphasised throughout the Feasibility Study led the System Design Team to make recommendations about the organisation of the Project Team that would actually design and implement the proposed system.

> To ensure success we believe that the best modern techniques in project management should be used. These include the managed control of joint applications development coupled with a "surgical team" approach to design and programming (i.e. a team led by one or two systems experts, supported by a number of skilled specialist assistants) [my emphasis].
>
> Separation of technical leadership skills from the different, but equally important skills of traditional project management is important in this kind of project. We address this issue by separating the roles of Project Manager and Project Consultant [8].

Although seemingly favouring the blue skies technological solutions of the technocrat the team seemed keen to broker a happy marriage between such an orientation and the need for a commercially oriented, deliverable system. The Project Manager would presumably serve to represent the concerns of the Steering Committee to the technical specialists, via the Project Consultant, and vice versa. The desire to adopt innovative untried solutions to the problems of the Grangemouth refinery was to be mediated by the desire to maintain a common core to RIS throughout the BP world and by the strictures of allocated funds and agreed finishing dates.

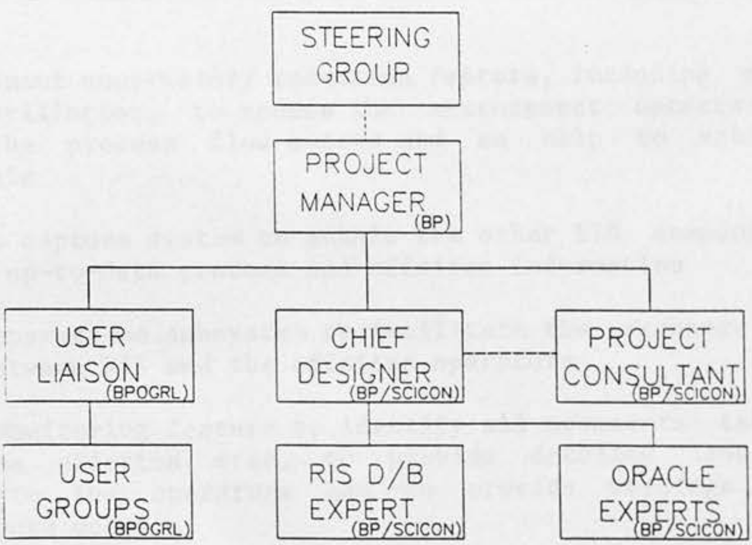
> Whilst.. we can support these kinds of developments [Grangemouth specific new solutions] what we don't want them doing is going completely berserk [5].

The demands on the Project Team were seen to vary over the lifetime of the project.

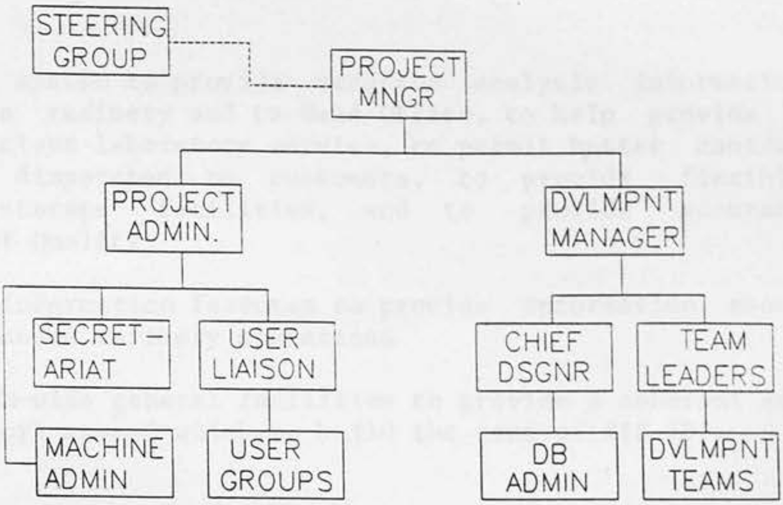
> The project naturally splits into two major parts. The first is the development, using JAD techniques, of a set of User Requirements Specifications and prototypes. The second part would take the specifications thus developed and transform them into a production RIS system, complete with documentation and full user training [8].

Thus, the System Design Team suggested a different team structure for each of the major parts of the project. These two structures are shown below.

Team for Part 1



Team for Part 2



The Stage 3 Report concluded with the following recommendations for a Grangemouth RIS that would meet the business requirements agreed with the Steering Committee. The system would consist of:

- a planning subsystem to allow the Production Department to respond quickly and accurately to changes

- a scheduling subsystem to enable Production to derive, from Head Office's strategic plan, targets for the process units and schedules for the blending areas

- performance monitoring facilities to permit process monitoring to be carried out in a more active and responsive way than at present

- a flow measurement uncertainty reduction feature, including mass balance reconciliation, to reduce the measurement uncertainty surrounding the process flow meters and so help to achieve production goals

- a process data capture system to enable the other RIS components to operate on up-to-date process and offsites information

- an offsites operations subsystem to facilitate the exchange of information between RIS and the offsites operators

- a movements monitoring feature to identify all movements taking place in the offsites area, to provide detailed routing information to the operators and to provide warnings if unexpected events occur

- a tank tracking feature to provide a continually-updated picture of the quality and composition of the material in the refinery tanks

- a laboratory system to provide accurate analysis information throughout the refinery and to Head Office, to help provide a fast and efficient laboratory service, to permit better control of material dispatched to customers, to provide flexible information storage facilities. and to provide accurate Certificates of Quality

- Head office information features to provide information about current and planned refinery operations

- a set of system-wide general facilities to provide a coherent and uniform framework around which to build the rest of RIS [8].

The team also proposed pursuance of their recommendations for improvements to those physical elements of the refinery concerned with the blending and introduction of additives to products.

Costs and Benefits

Expected benefits to be provided from improvements to the blending and additive introduction processes were given in the appendix of the Stage 3 Report. These areas merited a special cost-benefit consideration as they lay outside the original RIS development remit. The figures provided by the team suggested that implementation of the proposed changes in this area would be economically attractive, to say the least.

Detailed costings were also provided for the first part of the development approach recommended in the report. Two different estimates were given, one for the parallel specification of two RIS subsystems in this part of the project, the other for the parallel specification of six subsystems. The Steering Group were left to decide how many subsystems should be developed in parallel at the end of the Business Systems Analysis phase of the project in August 1989. According to the team..

> This number (say from two to six) affects project cash flow and end-date, but has little other on the project as any reasonable number of subsystems could be developed in parallel [8].

The total cost for the production of two prototype subsystems in part one was given as £585 970, whilst for the six prototypes this figure was £835 450 [8].

Agreeing the Framework and Establishing the Specifics

The Stage 4 Report was produced by three of the four authors who were jointly responsible for the first three stages [9]. One of the team members from Scicon was no longer involved in the writing of the study. The Stage 3 Report was reviewed by the Steering Committee on 15th December 1988.

> It was agreed at that meeting that the team should design a system including the MIMI system (containing LP, expert system and scheduling modules) and MTTS (integrated Movement Tank Tracking System). The remainder of the system is based mainly on Rotterdam [RIS] software, where it is appropriate, and follows the [RIS] philosophy of an integrated system built around a central database, which uses feedback of real-time information to improve planning and optimise refinery operations [9].

Thus the Steering Committee supported the team's contention that Rotterdam software should form the core of the Grangemouth system with advances from other implementations, particularly Bulwer Island, being adopted where "appropriate". The report emphasised the similarities between Rotterdam and Grangemouth in order to justify this approach whilst differences were noted but their impact was minimised. For example:

> Grangemouth Refinery is comparable in size to Rotterdam Refinery, but has a greater number of tags [or data collection points] in the process computers (some measured, some calculated). The actual number of tag values transferred and stored in the VAX [the computers on which RIS was to run] should be scrutinised carefully at the design stage, since this has an important effect on performance. Based on Rotterdam experience, we believe that Grangemouth should not need to transfer more data than Rotterdam is doing at present. The size of computer facilities required for a RIS system is therefore expected to be similar to Rotterdam [9].

Differences in the systems upon which RIS depended at Rotterdam and those upon which it was to depend at Grangemouth were emasculated through invocation of the spectre of performance worries. Thus circumstances at Rotterdam and Grangemouth were more closely aligned and "no-cost" Rotterdam software emerged as applicable to the Grangemouth situation.

Concerns of consistency between RIS projects within the BP world and the importance of (limited) centralised control of such developments were also deployed throughout the Stage 4 Report. Rotterdam was still the key exemplar, but other RIS developments within the group were to play an important wider contextual role.

> The use of VAX hardware supplied by Digital Equipment Corporation (DEC) for [Grangemouth RIS] will follow BPOI's strategy for implementation of RIS systems world-wide. It also fits in very well with the existing use of VAX systems at Grangemouth. Rotterdam RIS is being implemented on VAX computers, with Bulwer Island and Gothenburg refineries following in a similar manner [9].

The use of Oracle was justified in a similar way. Although the team recognised that experience of use of the system was limited in BP Oil, its use within BP Chemicals for the development of a number of systems enabled it too to take on the mantle of a group ratified solution. The fact that BP had negotiated very favourable discounts with both Oracle and DEC for the large scale supply of their products must also have played a key role in the selection of the hardware and software platforms for RIS at Grangemouth.

Specifying the Computer Architecture for Grangemouth RIS

With a broad framework in place, the specifics of the hardware platform for RIS at Grangemouth were established by the team. The RIS database was seen to require a large amount of processing power and the team sought to meet this requirement through the use of a cluster of two VAX 8810 computers [9]. The cluster was also to "provide processing power for central features of RIS (e.g. Planning, Mass Balance Reconciliation, Process Models" [9]. However, smaller distributed MicroVax computers were to be employed "where possible". Such an approach was seen to be more cost effective. It also serves to emphasise the partial nature of the view of refinery operations provided by RIS. A number of factors, including existing systems and RIS performance worries, combined to ensure that the central database would represent only a certain subset of refinery operations. The choice taken over the number of tags to be passed to RIS (see above) can also be understood in such a light.

The decision to make use of MicroVax computers required the use of a high speed network to link the computers and to this end the team suggested that an Ethernet network should be installed as part of RIS. It is not surprising to learn that this configuration of computers and linkages was a close emulation of that employed at Rotterdam.

Given the initial desire to limit the facilities required at Grangemouth to a similar size to that employed at Rotterdam, much of the Stage 4 Report was concerned with a comparative analysis of data traffic and sizing between the two refineries. Increases in the amount of data processed at the MicroVax level at Grangemouth were deemed not to have as significant an effect on performance as increases in the amount of data to be dealt with by the Oracle database. The team decided to suggest that attention be paid to this issue but put off the provision of a definitive solution until later in the development.

> The number of tags required to be stored in ORACLE will need to be carefully scrutinised, or a larger VAX system may be required to process the data. This number will only be available when functional specifications have been made [9].

Allowing For Growth

Since RIS was to be a project with a relatively long "useful" life in front of it, the team were keen to allow for subsequent growth in the processing capabilities of the system.

> All subsystems in [Grangemouth RIS] will be designed with room for expansion, and in a manner which can be further expanded should the need arise. Large parts of the software will be copied from Rotterdam and Bulwer Island, which have themselves been designed and built to be portable.
>
> The hardware that will support [Grangemouth RIS] will be VAX and MicroVAX computers supplied by DEC. Computers will be carefully selected to allow for future upgrade paths with the minimum of disruption. No top of the range computers have been selected. Where possible, new ranges of hardware have been selected in preference to older ranges, to lengthen the time before obsolescence occurs. The three main areas of growth are likely to be demands on processing power, disk space, and terminals & printers. Increasing load on communications is not expected to be a problem in the future [9].

We can see here another example of the team's ambivalent approach to the project. They sought to minimise the risks through "sound" planning and management of developments against the backdrop of turbulent technological change and a desire to be at the forefront of the information age. Throughout we can see a subtext, sometimes explicit, where the needs of Grangemouth are aligned with those that existed at Rotterdam serving to reinforce Rotterdam RIS's position as the basis for a solution at Grangemouth. Indeed an attempt was made to provide a metric for comparing the available software at Rotterdam to the needs of Grangemouth. The assumptions upon which this approach was predicated obviously served to partially ensure a good fit.

> ..similar computing power is assumed for [Grangemouth RIS] as is currently used for the Rotterdam RIS implementation. This is valid since Grangemouth is a similar refinery to Rotterdam, in terms of size and complexity, and [Grangemouth RIS] will include most of the functionality of [the Rotterdam] RIS [9].

Such an assertion stands in stark contrast to a number of the comparisons between Rotterdam and Grangemouth provided by other organisational participants earlier in our account. We now go on to examine how the team sought to establish measures of fitness of the Rotterdam software for the Grangemouth situation.

<u>Demonstrating Congruity Between Rotterdam and Grangemouth</u>

The team developed outline specifications for each Grangemouth RIS subsystem listing the functions to be performed by the subsystem and estimates of the number of inputs and outputs and the amount of processing required to meet the desired functionality.

> We then extracted similar information from the [Rotterdam] RIS documentation and made an estimate of the fit of the [Rotterdam] RIS functional points to the [Grangemouth] RIS in order to determine the re-usability of that Rotterdam subsystem.. This is expressed as the "GR-RIS FIT" factor.. From this we are able to calculate the amount of effort required to rework each component of the Rotterdam RIS.

A suitable team structure for each subsytem was assumed. From this, and from quoted day rates from Scicon, an average day rate and hence total labour cost per subsystem was calculated [9].

These measures of "fit", excluding those subsystems such as MIMI and MTTS that were to be adopted from elsewhere in the group, ranged from a low point of 78%, for the process data capture system, to a high point of 100%, for the tank tracking system, the planning system, the customs documentation system, and the trend monitoring system, with the spread of estimates skewed towards the latter figure. The specifications developed for Grangemouth by the team, were seen, by the team, to be largely consistent with the descriptions of the Rotterdam system, culled by the team, from the Rotterdam system documentation. There is certainly room for the self-fulfilment of prophesy within such an evaluation procedure.

Some other minor changes to the Rotterdam blueprint were also suggested. For example, an upgraded version of the hierarchical storage controller used for the connection of disks to the cluster was preferred, "owing to its superior performance. At Rotterdam, the performance of the disks is currently seen as a bottleneck to RIS, [and] the slower.. controller, which also has a lower capacity has not been selected for this reason" [9]. Still, in the main Rotterdam was to be starting point for development at Grangemouth, and for a number of applications it seemed as if it would be the finishing point as well.

Precedent, Performance and Flexibility

Certain performance characteristics of the final system were seen to depend upon choices made early in the development and these choices were seen to effect the "seamlessness" and availability of the final system.

> Applications have to be built within certain constraints before they can be run cluster-wide, on either or both VAX 8810's. At this stage it is expected that the ORACLE Database with associated menu system and screens will be available cluster wide, but that lesser used applications will be restricted to a nominated 8810, e.g. MIMI, process models [9].

Performance concerns, when congruent with the available Rotterdam solution, seemed to be gaining pre-eminence in the Stage 4 Report over the desire for a seamless integrated system. The relatively low (no) cost of Rotterdam based solutions obviously had a role to play here. This area of concern was particularly pronounced in the Stage 4 Report as it included more detailed estimates of development costs than those provided previously. We will go on to consider this costing shortly. Before doing so, it is interesting to note an example of the power of the Rotterdam precedent in determining the requirements of RIS at Grangemouth. As we have noted the Sciconic LP system was dealt a number of life threatening blows in the early stages of the consideration of Grangemouth RIS. The MIMI system evaluation underway at Bulwer Island was "going very well" [9]. However, the wide ranging use of the Sciconic LP at Rotterdam enabled its partial resurrection at Grangemouth, even though the Design Team had seemingly broken with Rotterdam's LP solution.

> Sciconic LP forms part of the.. package that is currently used at Grangemouth for scheduling and short term production planning. Sciconic LP.. is used at Rotterdam for the LP parts of the Mass Balance Reconciliation System (MBRS). It is quite possible that MIMI packages could be used for [Grangemouth] RIS to implement MBRS, although it is not possible to confirm this at this stage. Sciconic LP.. [has] been added to the [cost] estimate for this reason [9].

Costing the Proposed System

Costs for the changes in the blending area recommended in the Stage 3 Report were not included in the Stage 4 Report. Tentative costs had been included in Stage 3 but more importantly, these costs were seen as "independent of RIS" [9]. Provisional costings were however included for the hardware required to improve the acquisition of data for RIS, particularly data on the status of valves within the refinery system. The benefits from the more sophisticated information engineering involved in RIS were entirely dependent upon an adequate supply of appropriate information on the refinery, and thus these costs could not be considered independent. RIS was primarily about allowing people to see what they should be doing with the refinery, it was not to be a direct control system for the refinery. Thus, information supply was seen as integral to the RIS development, whereas the ability to act on that information was not. The importance of the ability to act upon the information supplied required its mention in the report, but not its inclusion in the project remit.

Measures of the effort required at Grangemouth to convert the Rotterdam starting point to Grangemouth solution were converted into costs, as we noted above. These costs, by subsystem, are reproduced below. The costs for software development included an estimate of the amount of user involvement required for a successful implementation. These costs were based upon "six users with a high level (75%) of involvement in the project, and six with a lower level of involvement (10%)" [9].

SUBSYSTEM	COST (£)
1. PLANNING AND SCHEDULING	129 600
2. OFFSITES	105 600
3. INFRASTRUCTURE	108 600
4. REPORTS	127 947
5. PROCESS MODELS	28 800
6. TANK TRACKING	0
7. PROCESS DATA CAPTURE	81 600
8. FLOW MEASUREMENT UNCERTAINTY RECONCILIATION	9 600
9. REFERENCE DATA	38 400
10. CUSTOMS DOCUMENTATION SYSTEM	0
11. TREND MONITORING	0
12. EXTRAS FOR GRANGEMOUTH	204 000
13. PROJECT OVERHEADS	323 883
TOTAL	1 157 430

These costs were provisional and were to be improved in the Stage 5 Report. Hardware costs were considered to be more accurate. The overall costs for the RIS development at Grangemouth suggested in the Stage 4 Report are reproduced below. Some of these costs, i.e. those for the Feasibility Study, had already been incurred, whilst some were so uncertain that they were not provided, for example, the staff costs associated with maintenance of the system.

OVERALL TOTALS

Capital Expenditure

Computer Hardware	1 698 444
Communications and Cabling	193 593
Computer Building	374 535
Instrumentation	305 000
Feasibility Study	180 000
Total	2 751 572

Revenue Expenditure

Software Packages	284 574
Staff Costs	642 980
Software Development	1 157 430
Associated Costs	109 113
Total	2 194 097

Total Expenditure

Capital Expenditure	2 751 572
Contingency (@10%)	275 157
Revenue Expenditure	2 194 097
Contingency (@30%)	658 229
Grand Total	5 879 055

ANNUAL MAINTENANCE COSTS

VAX Cluster	76 380	
MicroVax Computers	24 072	
VAXstations	13 140	
Terminals and Printers	18 384	
PC Hardware	1 692	
Software Packages	9 984	
Oracle Packages	6 816	
Ethernet Equipment	7 476	
Staff Costs		
Software Developed		
Total	157 944	(After First Year)

Thus the creation of RIS at Grangemouth was expected to cost almost £6 million. The development of RIS at Rotterdam had cost some $25 million [3]. RIS could be introduced at Grangemouth for approximately half the cost of RIS at Rotterdam, provided the Rotterdam system was taken as a starting point. The economics of system development provide perhaps the clearest illustration of why every effort was made to ensure consistency with the Rotterdam solution. The worries expressed by one of the systems managers at Grangemouth about the applicability of an external solution to the refinery's oil management problems [3] were more than counterbalanced by the economic advantages of such an approach. Not only would its introduction be cheaper but subsequent maintenance and upgrade costs could be spread around the group, potentially allowing significant economies of scale [5]. RIS at Grangemouth seemed destined to be a very close variant of RIS at Rotterdam.

The Final Report(s)

Two versions of the System Design Team's final report were produced: a draft Stage 5 Report in January 1989 [10]; and a Final Report in February 1989 [11]. These reports had only two authors, one from Grangemouth Refinery's Technical Department and one from Scicon's Energy Division. Thus, by completion of the study, the study team had been cut in half. There was a great deal of similarity between the two reports, but there were also some important differences. Both studies were...

...designed to stand on [their] own, ..and to summarise the key factors from the entire study for the Steering Group and other management [10,11].

Indeed, the Final Report was largely identical to the Draft Report, but it "also include[d] relevant findings from the RIS software portability study (..carried out in Rotterdam in the first half of February) in the final software estimates for [Grangemouth RIS]" [10] along with comments on the first draft. The development of RIS at Grangemouth looked certain to proceed.

> The costs and benefits of the project have been evaluated in detail and, as anticipated, the economics of a RIS implementation at Grangemouth are shown to be very attractive indeed. The findings are very much in line with those of the M&S BDU Strategy Study carried out at the end of 1987 [10,11].

The most obvious difference between the two reports was in terms of the costs and benefits attributed to RIS at Grangemouth. According to the Draft Report..

> The overall cost of the project, including £180 000 already spent, is estimated at £5.48 million, of which £0.91 million is contingency.
>
> The project has been phased over 3 years with expenditure of £0.8 million in 1989, and £2.25 million in each of 1990 and 1991.
>
> Benefits (net of increased revenue expenditure) are estimated at £2.51 million ($4.27 million) per annum. Assuming a ten year life for the RIS system, this equates to a NPV [Net Present Value] at 8% of £8.15 million ($13.85 million) and gives an IRR [Internal Rate of Return] of 37.5% [10].

Whereas in the Final Report...

> The overall cost of the project, including the £180 000 already spent, is estimated at £6.8 million, of which £1.1 million is contingency.

The project has been phased over 4 years with expenditure of £0.8 million in 1989, £2.25 million in each of 1990 and 1991 and £1.32 million in 1992.

Benefits (net of increased revenue expenditure) are estimated at £2.65 million ($4.51 million) per annum. Assuming a ten year life for the RIS system, this equates to a NPV at 8% of £7.86 million ($13.36 million) and gives an IRR of 36% [11].

In the absence of evidence of galloping inflation in the second month of 1989 one can assume that changes were made to the project through consultation with "the Steering Group and other management". Not only the costs and benefits, but also the timing of the project was altered. In the Draft Report, the team suggest that the Grangemouth RIS could be developed in about two years, without the involvement of an "unmanageably vast project team" [10]. However, the team thought that scheduled overhaul work at Grangemouth and a "likely shortage of funds in 1989 and 1990" made a three year development more prudent [10]. By the time of the Final report the project was scheduled over four years.

Other differences include the mysterious addition of an extra VAX 8810 computer to the VAX cluster. Although the Stage 4 Report suggested that the amount of computing power required by RIS was not definitively known, it did suggest that two VAX 8810's would provide sufficient power. This belief was maintained in the Draft Report, but the requirement had increased to three by the Final Report, with no explanation being provided for the upgrade. Costs for computer hardware, estimated at £1 698 444 in the Draft Report, had increased to £2 080 661 in the Final Report.

Costs to allow automatic valve status transmission for the proposed Movements and Tank Tracking System, included in the Stage 4 Report were "dropped" in the Draft Report [10]. However, in the Final Report a cost of £550 000 appears for "Offsites Instrumentation", again with no explanation [11]. Presumably automatic valve status transmission was picked up again.

Costs attributed to software development also increased between the Draft and Final Reports. This may be partially explained by the detail provided by the RIS portability study. Costs for software development were estimated at £1 063 705 in the Draft Report, and at £1 162 779 in the Final Report. "Associated Costs" also increased, from £109 113 in the Draft, to £238 558 in the Final Report.

Luckily however, the benefits to be derived from RIS had also increased. Summary annual benefits provided in the two reports are reproduced below to allow comparison.

Summary of Benefits	Draft	Final
	(thousands of dollars)	
Laboratory	192	189
Offsites	964	1 270
Trading, Supply and Production Planning	1 633	1 702
Flow Measurement Uncertainty Reduction	1 881	1 881
Loss Control and Performance Monitoring	179	80
Total	4 847	5 122

Improvements seem most pronounced in the Offsites area, presumably as a result of the picking up of the dropped Offsites instrumentation in the Final Report. Benefits were also improved in the Final Report through the assumption of different product prices for estimates to those used in the Draft Report. Product prices were between 1.7 and 11.5% higher in the Final Report [10,11]. In the Draft Report these prices were derived from "realistic differentials based on 1988 averages" [10] whilst in the Final Report they were derived from "realistic differentials based on Corporate Planning's 1993 market-led price set" [11]. In both reports however, the team were keen to emphasise that..

> The project is relatively insensitive to crude price.. and the economics are robust except in the most extreme circumstances, when refining itself would be uneconomic [10,11].

The team also claimed that the project would remain economically attractive even if extreme changes in the other assumptions on which the estimates were based were found to be necessary. For example, software costs of 100% higher than predicted would still result in an NPV of over £7 million and an IRR of over 30%. Similar figures were provided to cover the effects of sterling devaluation and of a delay in the achievement of benefits. RIS was seen as economically attractive unless refining itself became uneconomic [10,11].

Similarities Between the Two Reports

The majority of the Final Report(s) was taken up with a summary of the decisions taken on the basis of the Stage 3 and 4 Reports. The need for RIS at Grangemouth, defined in terms of competitive advantage, both within and outside the group, was re-emphasised and although the stability of Grangemouth's operations, relative to Rotterdam's was mentioned, similarities were again emphasised. The low financial costs and the reduction of risk thought to be associated with a Rotterdam based solution were of paramount importance here.

> Despite the physical differences between Grangemouth and Rotterdam there is a broad area of common ground in the way the various refinery functions fit together. These functions are closely integrated with a high degree of communication and data transfer between them. The [RIS] system developed at Rotterdam is specifically designed to meet the needs of such an integrated business, and because of its structure it is sufficiently flexible that it can be tailored to meet individual refineries' needs while taking advantage of the vast amount of common software which has already been developed. Therefore, an integrated RIS system could be installed at Grangemouth based on the same philosophy as Rotterdam [RIS], but tailored to address the particular needs for Grangemouth Refinery within BP Oil Manufacturing and Supply - at a fraction of the costs of developing such a system from scratch [10,11]

These concerns also impinged on the proposed timing of the project. Work was scheduled to commence in the second quarter of 1989..

> ...in order to take advantage of the experienced personnel who will become available at the end of the Rotterdam [RIS] project. Grangemouth will benefit greatly from their detailed knowledge of the RIS software. They can help to minimise the risks of the project, and also reduce the overall costs since it would be much more expensive to transfer the Rotterdam software without this type of experience in the project team [10,11].
>
> Virtually all detailed knowledge of the software which embodies the concepts of RIS resides in the heads of the prime contractor (Scicon [- which was soon to be sold by BP]) for Rotterdam [RIS]. This experience and knowledge could easily be transferred to Grangemouth RIS development if it were to proceed with minimum delay. Otherwise, the experience if not the knowledge is likely to be transferred to competing refineries [10,11].

One can see that Grangemouth's increasingly commercial orientation was also important here.

> As well as refining products for the UK market, a significant volume of Grangemouth's production is sold on the spot market. There is therefore a need for the refinery to be flexible and for the Trading and Supply staff, who are physically remote from the refinery, to have a good understanding of the refinery's potential at all times [10,11].

Risks were also seen to be minimised through compliance with broader corporate objectives that impinged on systems development. That is through the use of...

> ...hardware, software and communications components which are consistent with BDU-supported strategic directions for these areas of information technology [11].

The team demonstrated awareness of the economies of scope potentially provided by such an approach. They pointedly noted some overlap between work required for RIS at Grangemouth and work planned for Gothenburg Refinery. They suggested that "corporate benefits would be derived from common development between the two refineries" [10,11].

The team pointed out that improvements to the refinery's physical infrastructure had an important role to play in the successful implementation of RIS and the realisation of the potential benefits of flexibility. The two processes were seen to be mutually beneficial.

> A large investment programme is planned for Grangemouth refinery to improve its process flexibility. BP Oil will derive maximum benefits from this investment only if modern information systems - such as RIS - are put in place to support these enhanced facilities [10,11].

But although flexibility was seen as the key to success, and the data in the RIS database and RIS's flexible reporting facilities provided "the ideal foundation to support this type of activity" [10,11], an application support group was seen as necessary to "provide a rapid turn-round service for ad hoc queries of the database" [10,11]. Lack of IT knowledge and performance concerns maintained their role in putting a break on unmediated user access to RIS.

Assuring Future System Use and Support

As we noted earlier, concerns were raised by the Steering Group [5] about the achievement of the potential benefits offered by RIS after its implementation. However the team felt that the development approach that they had outlined would go a long way to ensuring success. These usage worries were particularly pronounced at Grangemouth, presumably as a result of previous externally "imposed" solutions and the emergence of as yet unmentionable problems at other RIS implementation sites [3].

> There is a risk that, while [Grangemouth RIS] will be built on time and to requirements, it will not be fully utilised by Refinery personnel - as has happened before with computer systems installed at Grangemouth. This risk must be eliminated by using JAD [Joint Application Development] techniques (to engender a sense of ownership of [Grangemouth RIS] in its users) and by backing up RIS development with suitable training, as we recommended earlier in the study [10,11].

Other techniques were used to engender a sense of accountable ownership on the part of the users as we will see later. Although keen to emulate the Rotterdam development's successes, the team were not keen to emulate its failures, particularly in terms of the lack of post implementation utilisation.

In spite of their emphasis on JAD's ownership engendering potential, the team suggested that little input would be required from refinery users during 1989, with the one exception being the Project Manager. They did however recommend the involvement of a member of Grangemouth staff on the team implementing the Laboratory System, with another member of staff recommended for work on the MIMI development. They would become their departments' experts on their most frequently used RIS subsystems. In addition, the team recommended the secondment of two members of Grangemouth's computer department onto the system development team, "in order that knowledge of the system may be retained after the development" [10,11]. The team heralded JAD as the path to an effective system that would be used by refinery personnel and then severely curtailed the application of the approach in practice.

User involvement was to become much more important in 1990, with a "significant input.. required" [10,11]. Since this input was deemed "critical to the success of Grangemouth RIS" [10,11], the team recommended planning and budgeting for its demands in the refinery's operating planning cycle. Inclusion of the requirement in the refinery's procedures for that period would serve to legitimate it in the eyes of the users and allow effected departments to justify the realignment of their staff. This would both raise the profile of the development and serve to signal implicit support from senior management. According to both reports, user involvement at this level would also be required throughout 1991, with additional numbers being required in the third quarter for RIS training. There was no additional requirement for user involvement in 1992 noted in the Final Report.

The buffering role of an application support team involved with the preparation of ad hoc queries along with general system maintenance requirements also had staff deployment implications for the refinery.

> To support the proposed RIS system, the refinery's Computer Department organisation will need to be expanded and skills broadened to include database design and administration, and 4GL programming. We envisage that seven extra people will be required to fill the following roles:
>
> | | |
> |---|---|
> | Computer Operators | 1 |
> | Applications Programmers (4GL, Database Skills) | 2 |
> | Software Programmers (Primarily Fortran, C) | 1 |
> | Hardware and Communications Specialists | 2 |
> | Database Administrator | 1 |
> | TOTAL | 7 |
>
> [10,11]

These staff numbers were over and above the current establishment numbers. The team did believe however, "that these staff increases [would] be offset by productivity gains in the Laboratory and other areas" [10,11].

Conclusions

The pathway from the instigation of the 1987 Strategy Study to the completion of the Feasibility Study Final Report is revealed as a convoluted and highly unstable co-ordination of elements in an emerging network. Nothing had yet been built, but innumerable stabilisations and changes to the project had already occurred. The system design team struggled to translate [12] and accommodate a number of "interests" ranging from corporate ideals, their idea of best modern IT practice, the changing commercial world, history, precedent, computer performance and economic considerations, to name but a few. The framework for a system that is seen to emerge is highly contingent and the fluidity encountered in the process is quite astounding. Moreover, the account provided is based upon rationalisations given some time after the fact. The reports are the outcomes of a complex decision process, that must have been, in the raw, almost completely incomprehensible.

However, consistency is emphasised throughout and Grangemouth appears as the recipient of the logical successor to Rotterdam's RIS. This facade of consistency was however itself soon under attack on one of it's key points: the centrality of the Rotterdam system "core" to subsequent RIS systems.

As we have already seen the ideal of flexible user access to information was already being significantly mediated by other concerns, but the philosophy of Rotterdam RIS possessed obvious interpretive flexibility [13] from the outset. The key concept of centrally stored integrated information was supposed to allow for site specific differences in practical utilisation. This philosophy had effectively become embodied in the core of the Rotterdam system. The core software was the vehicle through which the philosophy informing the Rotterdam system would be transferred to other refineries. However, this core was itself not immune to the effects of the accomodation of site specifics at each implementation. In the following chapter we examine how the software of the Rotterdam system was undermined as a basis for RIS at Grangemouth.

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CHAPTER SEVEN

ADOPTING A NEW CORE: THE BULWER ISLAND OIL MANAGEMENT SYSTEM

Introduction

Although the Final Report of the Grangemouth RIS Feasibility Study had concluded that the system to be built at Grangemouth would take as its starting point the Rotterdam RIS system, that is not what transpired. In fact, Grangemouth adopted the Bulwer Island Oil Management System as a basis for subsequent development and implementation. In the early part of 1990, when this decision was taken, the performance problems associated with the Bulwer system, described earlier, were not yet fully apparent. As we noted, the Bulwer system was originally expected to become the RIS Mark II for the BP Oil group, and a starting point for future implementations [1]. However, this was not the view expressed in the Grangemouth RIS Feasibility Study. Whilst some of the sub- systems used at Bulwer Island were to be employed as a basis for similar sub-systems at Grangemouth ".. [t]he remainder of the system is based mainly on Rotterdam [RIS] software" [2]. This chapter attempts to examine how this change in approach came about, and how it was justified.

Visiting Bulwer Island - Evaluating the System

Between the 7th and 11th of May 1990, a BP Oil member of the Grangemouth RIS Feasibility Study Team and a Scicon employee who was not originally involved in the Feasibility Study visited Bulwer Island Refinery in order to evaluate their Oil Management System (OMS) and..

> ..to decide whether it would provide a more suitable basis than Rotterdam's [RIS] for developing a similar system at Grangemouth [3].

The evident "Mark II-ness" of the Bulwer system within BP Oil was reflected in their comments, particularly with reference to it's greater adaptability and applicability to other sites. The Bulwer system was seen to be more of a "toolkit to assist management, engineers and planners in their tasks of maximising value added from the operation of the refinery" [2] than the system developed at Rotterdam. RIS systems were intended to take available refinery information and enable its transformation into commercial advantage. Indeed, the heightened commercial focus that was seen to derive from RIS implementations impinged upon development approaches to the systems themselves. Bulwer's system was starting to look like a more cost effective starting point for future implementations in general, and for Grangemouth in particular.

> The functionality of the Bulwer system (particularly Planning & Scheduling) is less complex, and it is more data driven, which gives the advantage that the system should be more applicable to different sites without major re-programming...
>
> Mainly because Bulwer's system is functionally simpler, we believe that the cost of developing a Grangemouth RIS is likely to be less if Bulwer software is used as the starting basis, and we therefore recommend its use [2].

OMS, although developed through the corruption of the Rotterdam RIS core, once again held out the promise of a common core for future systems. Rotterdam was not seen to be a similar refinery to Grangemouth any more and even if it were, wide applicability was no longer deemed to be derived from similarity. Rather, it resulted from a bare and simple framework coupled with the ability to derive and accomodate data driven detail. Not only would Grangemouth be able to develop their system more cheaply but a common core would be maintained through minimising the complexity of this part of the system. Future developments would benefit from the economies of scale that Rotterdam had promised but not delivered, through the reworking of the system core that had been undertaken at Bulwer Island. OMS embodied a new model for subsequent developments. A model that was seen, at the time, to be both "progressive and.. attractive" [4].

The two evaluators did, however, note some costs for all these benefits. The simplicity of the core system meant that..

> More complex refineries may require to add functionality, for example to allow them to schedule and monitor the offsites area [2].

Moreover, their recommendations were based upon rather scant evidence of the functioning and applicability of the Bulwer system.

> In the time available it was impossible to study the whole system in detail. The approach was very heavily dependent on explanation of functionality and design issues by Bulwer staff, [one individual] in particular.., supported by sampling of documentation and code [2].

The Feasibility Study had produced five volumes, each of seventy plus pages. At least four staff had worked on the project for over six months, yet one of its main recommendations was overturned by a four day visit to Bulwer Island by two people, which resulted in a nine page "Visit Note". Evidently Bulwer Island's OMS had become the solution in waiting. The authors of the Evaluation Report sought to show the commercial advantages of the sound Bulwer design practices in sharp relief against the ad hocery now seen to have been employed at Rotterdam. It is interesting to contrast these comments with those used to describe the Rotterdam RIS earlier in our account: "the RIS project at Rotterdam.. was one of the first to come in on time and within budget and actually do what it was meant to do" [5]. With the implementation at Bulwer, Rotterdam's RIS had ceased to be the jewel in the IS crown, it was now seen as a foil to OMS.

> Rotterdam [RIS] used a central database to link together, and feed data to, existing packages.. The way these packages were used in Planning and Scheduling, and the addition of a complex offsites system, resulted in some parts of the system being cumbersome and also made it difficult to identify core software which could be supported centrally.
>
> Bulwer took the [RIS] business (logical) model, took advantage of the experience gained on that project and attempted to develop a more flexible, more generic system. They ommitted or simplified functionality in some areas where they felt the functionality did not support the business effectively.. or involved unjustified manpower [2].

The advantages for group central support were key for the authors in their attempts to justify a major deviation from the Feasibility Study recommendations. Rotterdam RIS was seen to be merely a somewhat idiosynchratic pre-cursor, or exploratory prototype, to the systems nirvana produced at Bulwer Island.

> [These changes mean] that there is an opportunity to define appropriate central support, to ensure that other refineries benefit from Bulwer and Rotterdam's work, and to enforce a degree of discipline on future installations so that common software development will be possible [2].

The evaluators do not mention whether such discipline was enforced, and if so, where it came from, on the Grangemouth RIS project.

Reservations about OMS

Performance Worries

The two evaluators were obviously aware of the consequences of time limitations on their evalutation, and they were not uncritical of aspects of the Bulwer system. For example, they noted that during their visit..

> ..the loading on the main computer varied between nearly 100% when an LP was being run on it and PDC [Process Data Capture] historical recovery was in progress, and quite low loading at other times [2].

Although cautioning "other refineries installing the system" to make significant investments in computer hardware, as Bulwer had done, in order to reduce the risk of overloading the system, the evaluators' main concern about machine loadings at Bulwer was that they "..made it very difficult to make an objective assessment of system response" [2]. Given the concerns expressed throughout the Feasibility Study about machine loading, this response seems inconsistent and inadequate. A loading of "nearly 100%" would preclude simultaneous access to the database for complex queries and would undoubtedly result in the "..enquiry and reporting capability.." for "..trouble shooting investigations" [6] only being available part time. Practically speaking, at certain times "..all systems and users.." would not "..have free access to the data via a common pathway" [6].

Moreover, the use of the word "objective" in this context seems somewhat extraordinary. Perhaps no standard assessment would be possible, and perhaps it would be more subjectively annoying when attempting to run queries at certain times. But the key point remains, "objectively" the data base would not be available for complex queries or for other applications when the machine loading was of the magnitude described. Indeed, as we noted in an earlier chapter, the machine loading caused by the LP system constructed at Bulwer was later to be revealed as responsible for the downfall of that system. Thus although concerns were raised, the seeming inevitability of the OMS solution precluded their full explication by the evaluation team. They seemed, to a certain extent, to know what the outcome of their evaluation should have been.

> These things sort of happen. BP is a loosely well knit company [laughter] and so there are fora in which refinery management get together, production controllers get together. These things are aware, interest is generated, and the formalisation sort of evolves [4].

The evaluators did note other performance worries, but these were deemed not to impinge on an OMS based system built at Grangemouth if Bulwer's experience of the problems was exploited, although "..[i]t was rather difficult to verify this because of the machine loadings mentioned [previously]" [2].

> The hierarchy structures in the database would not normally be recommended where performance is a serious concern. However, Bulwer believe that they have overcome performance problems by careful tuning of database enquiries [2].

Again, free and open user defined querying of the database seems to be the victim of competing design criteria. The flexibility of Oracle's relational database system was to be used to enable multi-site applications of a family of similar technological systems, not unmitigated flexibility for the users of each of these systems.

Other Conerns

The evaluators did express other concerns about the portability and sustainability of the Bulwer system. They were perhaps not as central as the performance worries described above, but they were each capable of aggravating the smooth transfer of the system, and their combined implications were potentially devastating for a successful and cost effective tranferrence.

As we noted earlier, the authors of the Feasibility Study for the Grangemouth RIS had made reference to the key role that they expected experienced staff from the Rotterdam implementation to play in any Rotterdam RIS based implementation at the refinery. Now that the Grangemouth system was to be Bulwer based, the issue of experienced staff availability took on a new importance. Shifting staff between two refineries in Europe is one thing, but shifting staff between the Northern and Southern hemispheres is quite another. Moreover, the small size of the Bulwer refinery meant that "spare" BP Oil staff with experience of the system implementation were few and far between. Staff who possessed this knowledge were required to support the system at Bulwer and to transfer their skills to the rest of the Bulwer Refinery staff.

> Knowledge of the Bulwer system is concentrated in a few key people. The risk of porting the software could be reduced significantly by [getting] one or two of these people involved at the start of the project to pass on their detailed knowledge of the software.
>
> These staff are scarce however and it is not certain that any will be available to assist Grangemouth [2]

We will see later how even at the larger refinery of Grangemouth, RIS expertise, post implementation, was at a premium.

In comparison to the approach advocated in the early stages of the Grangemouth RIS Feasibility Study, Bulwer Island had been woefully lacking in their commitment to sound project management procedures. Grangemouth intended to use their own staff, staff from Scicon, and some support from the Oracle corporation to implement their RIS system. They adopted Scicon's approach to system analysis and emphasised the role of firm management control by the Design Team and the Steering Committee in the successful delivery of a useable system. Lessons from Rotterdam's good practice and successful outcome were being explicitly learnt at Grangemouth. However, the Bulwer system was to be RIS Mark II, the starting point for future installations since Bulwer's system had improved upon the Rotterdam design. Apparently though, this had not been achieved through the application of sound project management disciplines.

> ..the code was produced by a mixture of several different software houses and project staff..
>
> The lack of QA [Quality Assurance] applied to external contractors raises concerns about the robustness and maintainability of the code they produced.. [P]rojects porting the software would need to satisfy themselves that the quality of code was satisfactory for it to be supported successfully after implementation.
>
> ..coding standards are.. variable. Bulwer did not impose their own standards or quality control procedures on the software houses. They tested the delivered code for functionality only. It is therefore difficult to make a judgement about the quality and robustness of the code [2].

The lack of quality assurance increased the need for experienced staff in subsequent installations of Bulwer type systems, and these problems were further exacerbated as the lack of central control also extended to the production of system documentation. With variable coding standards and a lack of knowledgeable staff, system documentation would prove vital to an adequate understanding of the system.

> Without input from Bulwer staff, the importance of accurate, readable documentations increases [2].

However, although..

> [d]ocumentation is good at the high level.. there is some concern about the standard of documentation at the more detailed level. Because the code was produced by a mixture of several different software houses and project staff, the documentation standards tend to be quite variable. In addition, our random sampling seemed unnervingly successful at finding "holes" [2].

The contradictions between the acceptance of the Bulwer starting point and the recommendations of "good practice" made in the Grangemouth RIS Feasiblity Study either went unnoticed or unacknowledged by the evaluators in their Visit Note. The performance of the Bulwer system was almost impossible to ascertain "objectively" and the way in which that performance was achieved was inpenetrable due to the poor quality of documentation and checking of coding standards. Nevertheless, OMS was the solution in waiting, RIS Mark II, the starting point for future implementations, and thus it was to be the basis for the emerging Grangemouth system.

The brevity of the evaluators visit was ameliorated by the subsequent production of a detailed evaluation of the Bulwer system in August 1990 [7]. However, this report was produced some time after the Bulwer system had been "fixed" as the core and basis of the Grangemouth RIS development in the "Grangemouth Refinery Information System Overall Design Report" produced by two members of Scicon's Energy Division in May 1990 [8].

Stabilising the Starting Point - The Overall Design Report

> Once approved, this report becomes a working project document, to be used by the designers of the Grangemouth system as a framework for the design of individual subsystems [8].

The Grangemouth Refinery Information System Overall Design Report was produced in May 1990 and sought to stabilise a framework within which RIS at Grangemouth could be built. The flux that had characterised the Strategy Study, the Feasibility Study and subsequent documents was to be partially hardened to produce a relatively fixed structure and allow consistency between the central database and each of the subsystems of RIS at Grangemouth.

Many specifics were not finalised in the document, these would be fixed during implementation, but it did provide enough consistency to allow "the detailed design and development of individual systems within RIS, independently of each other" [8]. Since RIS was to be an integrated system, certain key characteristics of the overall system and the design approaches to be adopted for subsytems were fixed to enable independent development of those subsystems.

> [The] report presents an overall logical design for the Grangemouth Refinery Information System (RIS), in terms of a functional analysis and a logical data model, together with other design considerations [8].

In essence, the Overall Design provided the necessary pre-requisites for the modularisation of the design and implementation of RIS. The inputs, outputs and functions of each subsystem were specified, and the design of the central database was established.

> Since RIS systems tend to be tightly integrated, the operation of system functions is heavily dependent on the physical structure of the database and its contents [7].

RIS was to be developed from "software from RIS-type systems at Rotterdam, Bulwer Island, and Gothenburg" [8] and from scratch, where this was deemed necessary. In particular, the logical data model at the heart of Grangemouth RIS was..

> ...derived from an analysis of data structures at Grangemouth, together with knowledge of the Rotterdam and Bulwer Island logical data models [8].
>
> In the design process, the general principle has been and will be followed that the data model will copy established RIS data models - in particular that from Bulwer Island - unless there is a requirement to deviate from it [8].

The centrality of production planning and scheduling to RIS and the decision to adopt the "Bulwer Island Strategic Target Setting System" as a basis for these subsystems, made the OMS database the most appropriate starting point for Grangemouth.

Through its acceptance in the Overall Design Report, the Bulwer Island central data model formally became the basis and core of the Grangemouth RIS despite the fact that the Bulwer Island system was, at the time of the Report, only "nearing completion" [8]. It had not been up and running long enough for its deficiencies to be noticed.

Reassessing Bulwer Island

The detailed Bulwer system evaluation produced in August 1990 [7] was intended to "assess how well the Bulwer System fits Grangemouth's requirements". The Overall Design Report had formalised the replacement of the Rotterdam starting point with a Bulwer based system. Essentially, the Grangemouth to Rotterdam "fit" calculation carried out in the Feasibility Study was repeated in order to specify the fit between Grangemouth and Bulwer Island. The comparison was primarily concerned with the central data model and the application systems developed at Bulwer.

> The Bulwer system's facilities to capture data, and to provide interfaces with external systems, are of little interest to Grangemouth because of the different systems in use at Grangemouth [7].

The deficiencies of the Bulwer system, noted and briefly described in the Visit Note were reiterated, but it was nevertheless concluded that Grangemouth would..

> ..adopt the physical database design from the Bulwer system and.. avoid changing it unless modifications are required to support local needs [7].

The authors did however, demonstrate an awareness of the tightrope they were required to walk in the implementation of RIS systems: between reflecting local circumstances and maintaining a common core to all similar systems.

> A common physical data model is crucial if there is to be any hope of common software for RIS systems. However, different sites will have different requirements and implement different subsystems which will require different things from the database.. There is a strong danger that the implementation of

> effective subsystems at Grangemouth could be compromised by idiosyncrasies in the data model which must be preserved for the sake of common software [7].

Indeed, notwithstanding the commitment to a Bulwer system basis, the document was far more critical and reflective on the suitability of the Bulwer system for Grangemouth. This critique was not restricted to consideration of the impact of local circumstances. It extended its purview to assess the Bulwer system in terms of its performance and design characteristics. At Bulwer Island, for example..

> Many complex views have been defined to extract data to populate MIMI tables and sets. The effort required to evaluate these views must place a significant overhead on the initialisation of the LP run and impact on the database response to Oracle users. The strategy for storage of MIMI data in Oracle should be reviewed to establish whether the Bulwer mechanisms should be modified for Grangemouth [7].

These concerns lead to strategy proposals for the development of the system that explicitly left some space for further evaluation before committing designers to a replication of the Bulwer system. It may have been that the problems associated with Bulwer's system, described earlier, were becoming apparent and the authors of the Bulwer Evaluation Report were keen to defer judgement until these problems had been solved, or declared unsolvable. Thus, the Evaluation Report did not recommend strict adherence to Bulwer's approach. In the planning area for example...

> The Bulwer system provides a set of tools for the creation of a production scheduling system for Grangemouth.. However, because of performance problems with some key parts of the system,.. and reservations about how Bulwer have represented their refinery within the LP, extensive work is still required to realise Grangemouth's requirements [7].

In fact, although the commitment to utilise the Bulwer physical data model as a core for the Grangemouth system was reinforced, the Evaluation Report made great play of the lack of specific definition of requirements for a number of the proposed Grangemouth subsystems, and used this uncertainty to leave open the potential for departures from strict adherence to the Bulwer base. The Visit note and Overall Design Report had firmly instated Bulwer Island's model as the core of the Grangemouth system, but the detailed Evaluation Report sought to ensure sufficient space remained for system designers at Grangemouth to build the system the refinery "wanted". Where the specific requirements for Grangemouth subsystems were known, their deviations from software available from Bulwer were noted, lending further power to the Grangemouth designers' elbows.

By the time the Evaluation Report had been produced, the need for some changes to the <u>database</u> for Grangemouth had already been established. The Grangemouth designers' room for manouvre was being simultaneously closed and opened all the time.

> The database definition at Grangemouth differs significantly from that at Bulwer in certain areas, in particular the definition of Grades and Grade Specifications are markedly different [7].

However, the general strategy of maintaining the Bulwer Database physical design remained intact, as did the intentions behind the strategy. "This is to maximise the benefit to Grangemouth of past investment in RIS systems" [7]. Changes to the physical database could be made, but they necessitated a strong justification, particularly if they were deemed to be "High Risk". Thus, the physical database design strategy was given as follows:

> The basic principle for the design of the Grangemouth Database is to adopt the Bulwer Database physical design without change [emphasis in original]. This means that the Grangemouth database will exhibit most, if not all, the characteristics of the Bulwer database - for better or for worse.
>
> Changes will only be considered if they are required for the support of additional system functionality. Changes will be treated according to whether they are High or Low Risk.
>
> High Risk changes are those which seek to modify existing structures. For example, to change the contents of a field.. All such changes will be assessed for impact on the existing system. High risk changes will be avoided if at all possible.
>
> Low Risk changes are those which seek to add new structures to the database. For example, to a new field.. All such changes will be assessed to ensure that they are not actually seeking to replace existing structures and that they cannot be accommodated within the existing structures. Low risk changes will be adopted provided they do not run against the overall philosophy of the physical db [database] design or pose a risk to compatibility with other systems.
>
> It should be emphasised that physical database changes should only be considered for the support of additional functionality or flexibility. Stylistic changes will not be made for the sake of them [7].

In the next chapter we examine how the system designers and implementers utilised the space left for them by the Overall Design and Bulwer Evaluation Reports to build a RIS system at Grangemouth.

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CHAPTER EIGHT

ENGINEERING THE SYSTEM AT GRANGEMOUTH

The System Builders

The RIS system to be built at Grangemouth was designed and implemented by a team made up of both Scicon and BP Oil employees. The size and constitution of the team varied through the development and implementation process. From the small System Design Team of four people who undertook the Grangemouth RIS Feasibility study, the team was to grow to a peak of between 25 and 30 people [1]. At the start of the implementation approximately half of the team were BP employees, although as the implementation progressed more Scicon staff were taken on to carry out programming work. At it's largest the team was expected to be..

> ..probably about 27 people of which ten [will be] BP [and] 17 Scicon, something of that order. That includes users, full time users on the BP side [seconded onto the project]. So in terms of BP programming staff, there's only three.. as opposed to about a dozen Scicon I suppose [1].

Non-programming staff were primarily involved in systems analysis, specification and administration.

> Scicon come along with the technical skills, the actual information systems skills and also with the experience of what they've done with implementing RIS's in other refineries. And Grangemouth is providing primarily the user expertise, the local expertise, but also the people to support the system in the longer term [1].

Unfortunately, it was impossible to involve Scicon staff in the study as they insisted on charging the refinery full consultancy rates for any time spent talking to the researcher. It was however possible to speak to all of the BP programming staff on the project and a number of the seconded users.

In this chapter an account of the implementation process is provided from interviews conducted with the BP programmers and other personnel with systems responsibility, both within the refinery and at BP Oil's Corporate, European and UK Head Offices. The material derived from interviews with seconded users is dealt with more fully in the following chapter.

The interview data gathered by the researcher allows consideration of the RIS story, up to and including the establishment and early development of the major sub-systems that were to communicate through the central database.

General Orientation

The BP staff involved in the Grangemouth RIS implementation adopted a general approach to building the system that sought to deliver a commercial advantage to the refinery. As we noted earlier, most of the value added opportunities in refining are oil based [2] and so the core application of the developing RIS system was seen to be "Production Programming" [3]. RIS was seen to be an integral element of a general change that sought to render activities in commercial terms in order to engender a commercial orientation within the organisation.

> The objectives of the system are to take operational information and hold it centrally, and then to analyse that information in terms of commercial rather than operational criteria. It's part of a wider project to alter the focus of the plant to emphasise commercial, financial issues [4].

The lack of this sort of information prior to RIS was seen to be one of the key reasons behind the lack of demand for RIS from the site and also one of the key benefits of the introduction of a RIS system.

> You've got to take the control, it's no good putting plans in in isolation from commercial reality. And what RIS attempts to do is to try and make the whole refinery more commercially responsible, aware, i.e. to increase that degree of benefits control, performance measures [2].

The "need" for information to improve the refinery's performance could not be articulated without information on the refinery's performance.

> The measures on refinery performance were a lot cruder than they really are today, and they're pretty crude today. The refinery had measures of value added type profitability, but they're rather imprecise and aren't given quite as much credence as they would be if it were a solely operated company... Since the refinery wasn't really operating in a plc mode and since it's bottom line wasn't all that visible with credibility, that's why I think it wasn't pulling this into being beforehand. In a sense it's the management environment which sets the expectations and the criteria of success, for what [the refinery] is actually a division within Manufacturing and Supplies. It's an organisational issue really [2].

Managers at Grangemouth were not seen by the implementers of RIS to be generally keen on information systems. This was deemed to be partially a result of "overselling in the past" [3]. However, as we noted in the previous chapters the introduction of RIS was virtually a foregone conclusion. Sceptical managers may have been able to ignore RIS or partially divert its developmental trajectory but they had little alternative but to accept the implementation of some sort of RIS type system. The project was further legitimated by Scicon's involvement and the implied authority behind their system's "professionalism".

The implementation "proper" started in July 1989 and in the first year the system builders' work consisted of the production of an overall design framework for the system (see previous chapter) and the implementation of a stand alone proprietary laboratory analysis system [3]. During the following year the Bulwer Island database was implemented and the changes required for Grangemouth were consolidated. A great deal of effort was devoted to infrastructure changes, basically a very widespread data capture, to ensure a well populated database. These changes were seen to provide "little direct benefit for the refinery" [4] but were a necessary pre-requisite for the subsequent development of major applications. The choices over which data should be captured and at what level of resolution they should be recorded reflected wider concerns surrounding the overall purpose(s) of RIS and the perceived limitations of the technology employed.

> There was a compromise made as to the number of operational data collection points out of that mass of ironwork out there on the refinery that would be collated for production planning purposes. The design is for relevance in the overview level of production control, not in terms of the technical control or operations control of the plant [2].

As we noted in the previous section, the framework established prior to implementation allowed and necessitated an ongoing evaluation of RIS's constituent parts and their integration. Experience derived from earlier implementations provided some consistency and a guide for action here.

> We've never been able to do a complete specification, we've always had to do it kind of piece meal and accept the risks that go with that. We've been able to do it because we've known enough about how it's been done at other sites to be able to cope with the changes that come through with that [5].

The physical database adopted from Bulwer Island's OMS system may be seen as an artefactual embodiment of this general precedential guide to design.

The Central Database

A central database at the core of RIS to organise the production of commercially oriented information was the corner-stone of the system at Grangemouth. The aim was to have "common rather than distributed information" [4]. A central database would not only provide a neat way of organising the interfaces of a number of subsystems [6], but the sharing of information that such an organisation encouraged was seen to enable a wider integration of the refinery system.

> Hopefully the sharing of information in a common database will result in a better understanding and working relationship between departments [4].

The database implemented was seen to be..

> ..still very much based on the Bulwer Island model. We still use Bulwer tables as a starting point, but we don't implement any columns we don't require, and we've implemented columns of our own as needed. The basic philosophy is to use the Bulwer model until we cannot. We've not been able to use as much of the Bulwer model as we first expected. Bulwer Island is a much simpler refinery than Grangemouth and so we had to diversify from the model they used [4].

Indeed, one of the designers said that "we've had to make more changes to the Bulwer Island model than I would've expected use of the Rotterdam model to involve" [7]. Staff at the refinery were keen to ensure that they did not transfer the Bulwer system's performance problems along with its central database. Again, embodied and contextual experience were seen to play key roles in minimising risks. Technological positioning was an important battle ground here. Staff brought into Grangemouth to produce the system were keen technological innovators (see earlier description of the Feasibility Study's orientation) whilst "indigenous" staff were happier to adopt tried and tested solutions.

> Our general policy has been not to take technical risks. Yesterday's blue sky is quite good enough I think and no nasty surprises has been a policy I've been very happy with. And I do have a say because although the RIS project is separately managed, separately funded, and separately staffed, I still end up with the responsibility of running it once it's been developed, which of course is its benefits stage [2].

Grangemouth's location and particularly the local skill base also had an important role to play here.

> We are in a relatively small town in Scotland [and] expertise in this sort of development has to be imported. We're quite reliant upon this little set that is in place. Why start trying to reinvent the world or invent a new world halfway through? It doesn't stack up too well [2].

Within the wider BP Group the adoption of a Bulwer Island starting point was losing some of its attractive gloss as the system's performance problems became more apparent and the issue of a centrally supportable core once again reared its head. Bulwer's evident Mark II'ness had not turned it into the basis of all future implementations as the visitors from Grangemouth had suggested. It was now seen as something of a technological blind alley, a mistake in systems design from which future designers could learn important lessons. Conceptions of appropriate solutions to business problems had to be congruent with the "technological" capabilities of the systems that were to support them.

> [At] the second RIS implementation in Bulwer Island.. they overstretched themselves in terms of the production system design and because of that they basically failed to meet their goals and are still trying to implement the system. They were just trying to go too far with the technology available [8].

A group reorganisation emphasised the problem of centrally supportable core software. In mid-1990 the BP organisation was split into geographical areas, with BP Europe providing a corporate centre for European operations [8]. Not even the smaller enclave of BP Oil Europe could maintain a centrally sanctioned core for RIS systems since..

> ..we were locked into a lot of these developments before Europe was formed. So within Europe everybody bar Grangemouth has got the Rotterdam system and.. with hindsight I don't think Grangemouth would've gone for a Bulwer system. Quite honestly it's not lived up to their expectations and I think we would've liked to have harmonised in Europe if we'd had the opportunity [8].

The promise of centrally supportable core software could only be fulfilled by a new generation of RIS systems, built from a fixed starting point. For the present generation cost savings could be made by importing and modifying software developed elsewhere, but there was to be no centrally supportable tool kit.

> The original RIS project when it came into Grangemouth came with the expectation that about 50% of the code and design back would be portable and the rest of it could be written, so you get basically a half price project. You could spawn the economies of scale of having lots of refineries within one company and as far

> as Grangemouth RIS project is concerned I think that assumption has turned out to be largely true. Approximately 50% has been obtained free and the remaining 50%, cheap at eight million [pounds] I suppose [2].

However, as we noted in earlier chapters, although each site only had to develop about 50% of their own system, the 50% imported was not common to all sites. "Bits" of software were available elsewhere, cost free, but there was no consistent central core around which each system was to be designed and thus the possibility of cost effective central group support was strictly limited. In the next section we examine how the system builders set about implementing a number of system applications around the central core that they were "locked into".

Building System Applications

As we noted above, the key application of RIS at Grangemouth was the production planning and scheduling system. Particularly with regard to the more detailed area of production scheduling, the system builders recognised that they couldn't automate all the decisions that staff were required to make "so instead we're aiming to provide the information to make those decisions and provide facilities for him (sic) to use that to allow 'What if?' analyses" [4]. For example...

> The MIMI LP will provide a first cut schedule based on the planning information. This will then be given to the scheduler so that he (sic) can fine tune it on the basis of his knowledge. We're aiming to get an approximately 70 - 80% correct solution from MIMI [4].

The authors of the Feasibility study had been keen on the potential of an advanced scheduling tool with expert system functionality, MIMI-S that was promised in the near future by MIMI's suppliers. However, in the atmosphere of technological backtracking that pervaded refining systems at the time of the Grangemouth implementation this was seen to be an unworkable technicist solution. The decision to reject MIMI-S was also dependent on earlier choices concerning the level of resolution to be used when recording and modelling the refinery within the RIS system, choices predicated upon knowledge of the performance implications of the more complex refinery representation that had been employed at Bulwer Island.

> If we took MIMI-S as it was there would be a lot of work involved taking the MIMI-LP as output and breaking down the schedule to tank level because our LP isn't defined to tank level. So what we're instead taking is the raw LP output and we are breaking that down ourselves to tanks with what we see as a relatively straight forward algorithm [1].

RIS was a tool for, not a replacement of, refinery personnel. Staff savings were, as we noted, expected in some areas but the increased computer support that RIS was seen to necessitate meant that there would be little or no net reduction of staff as a direct result of the implementation. The RIS development was to be kept distinctly separate from improvements to the process <u>control</u> systems [5].

> The object is to give people as much information as they need to do their job, without trying to do their job for them [1].

Both the indigenous systems staff and the programmers brought in to build RIS were adamant on the distinction between RIS and the systems that directly controlled the operations of the refinery. There was no attempt to automate the control of the refinery under the auspices of the RIS system. Moreover, even the possibility of future developments in this direction was largely dismissed by the systems staff interviewed.

> If there is to be increased automation then that added sophistication needs to be within the control system itself and anything that comes from RIS would be in the form of price data, or some constraints and targets which would feed into the process control system. There are too many safety implications of expanding RIS into the process area. It's got to come the other way, perhaps being driven by information coming from RIS. There are two different standards of reliability that you have to consider in the two systems [5].

> I think the perception is that at a certain level of detail process plants like this are a little bit like weather systems. There is a degree of unpredictability built into them and to retain responsibility for that continuous operation you probably need to put some human being in charge of it. Somebody who, if you like, can put the umbrella up when it's actually raining rather than when the weather forecast says it should be. And I don't see full automation as being in the scope of plans or realism for refineries. It is a question of how clever one can be, how smart, how effective [9].

Indeed, at an old site with built in "unpredictability" and concerns about the consequences of the automation of control, the importance of accurate and timely management information was seen to increase. Not only was an automated control loop for refinery processes rejected, simple automation to allow remote human control of valves was also "impossible" for economic reasons. Benefits of such an automation were not seen to "warrant" or "justify" the investment required [2]. As a result, better information was required due to the lack of immediacy in process control mechanisms, and in turn, this lack of immediacy was seen to introduce a constraint on the benefits derivable from RIS information.

I think it means that if you've got operators running round the off sites and tankage areas in order to make blends and line them up to ships.. you actually have to be as certain as you possibly can that the plan to which they're operating is viable and good, because you haven't got the chance of changing things so robustly at the last minute. And that means that it should pay off, it should add to the overall value, but it would be even more error free I suppose if you could automate that final step as well, or increase the automation in it [2].

There were however problems noted with this approach, fundamental questions needed to be asked about the functions of the refinery operators. Given that the control and planning systems were not to converge, effort was to be devoted to improving the interface between them, that is, the operators role.

I think the challenge in the future and the interface that is going to be concentrated on is actually the human interface. What is the operators job? What are his (sic) tools? What information is he being given and what responsibilities has he got? [9].

Whilst it was...

..quite conceivable that in years to come the process control side will grow some degree of.. control intelligence, IS characteristics, so long as it's in real time and deals with automated oil flows, I don't have a problem [9].

It was, however, important to ensure that RIS was not viewed in the same way.

I think we have to be careful.. that we don't kid ourselves that a RIS project is in real time and is associated with activating control valves [2].

These problems would be particularly acute for operators who were not only receiving information from RIS but also directions and information from the Honeywell process control system. Given that the systems did not look likely to converge in the near future, there was a "need to adjust human resources to technical capabilities" [2].

These differences and their implications needed to be made crystal clear to the operators.

> Look at it from the process operator's perception: at the moment he's going to see two different screens, very different things, and he's probably going to be slightly confused. He's getting some information out of his Honeywell control screen, which is real, and some of it's calculated. And he's got plans which are there and targets to meet [2].

We go on to look at RIS's implications for roles within the refinery in the following chapter.

Returning to the core application, the MIMI LP system was seen as a success by the system builders: "The Production Department seem to be very happy with it" [4]. Wider benefits were seen to have accrued from the introduction of a new LP. Staff in the Production Department "had a lot of work in terms of understanding why they're getting particular results" [4] due to the fact that they "had to go through and test MIMI against Sciconic" [the LP system used prior to the introduction of the RIS-based MIMI system] [4]. As a result Production staff were seen to "understand the results they're getting a lot better" [4]. Benefits from RIS and their management are considered in more detail later in this chapter.

Other applications that were deemed to be "more important perhaps in that they are the more commercially orientated, rather than the more technically orientated activities", such as Performance Monitoring, were "much less clearly defined" [4]. There was no problem with the availability of data for the support of these applications, rather the problem was in terms of "identify[ing] what you are actually monitoring, what does it mean, performance monitoring?" [4].

> Are you measuring against your LP targets? Are you measuring against your process model targets? Are you measuring against both I suppose? And what sort of sensitivities and how do you want to see it? How do you want it grouped? [4].

Similar concerns were expressed over the specifications for the Mass Balance Reconciliation System. Whilst a need was recognised for "those types of report" [4] the requirements for producing the reports were harder to specify. Requirements needed to be "looked into in more detail" [4]. For example..

> The standard approach is to say, well, we assume we don't lose anything.. and you reconcile the flows so that you say "Well this flow meter must be reading incorrectly." And that's a self fulfiling prophesy I suppose [4].

A Movements Monitoring System was also under development and was seen to be particularly important for the management of off sites operations [1]. This system was to be built around a prototype system that had been developed at Vohburg refinery. A decision was taken by the BDU Systems Group to split out the interface of the system from its functionality. Work on the interface was underway at BP's central engineering and research centre at Sudbury, whilst the functionality of the system was seen to be "too refinery specific to warrant building a generic and Grangemouth have grudgingly accepted that" and were to build that part of the system themselves [1]. Again we can see the conflict between reflecting local needs and the demands of centrally supportable software. In building the functionality of the system at Grangemouth...

> ..the main driver will be cost, but we will consider possibilities for a generic system. The centre can far more easily use genericism as a justification for development costs

than we can. At Grangemouth genericity will come second to budgets and deadlines. The case is similar for large parts of the scheduler [1].

Some of the problems of genericity and specificity of applications were seen to be soluble through the use of more flexible reporting formats. The demands of genericity not only impinged on systems to be used between refineries, but also on those to be used within Grangemouth. Standard reports may not reflect and accommodate particular concerns. Flexible reporting tools provided a potential solution.

> I think I did at one time think that these flexible reporting tools would actually reduce a lot of the standardised screens we needed. I'm not so sure that that's true. I think what it does do is stop people getting irritated by not being able to do things with the standard screens [5].

In the next section we go on to consider the provisions made for database reporting at Grangemouth. In some senses applications can be considered as a subset of database reporting, but we will be more concerned, in the following section, with the tools provided to users to help them deal with the relatively non-repeating issues that confronted them in their work in the refinery. These issues are not infrequent. As we noted above, the refinery was seen as a complex system which possessed a certain amount of in-built indeterminateness and unpredictability. And the increasing volatility of Grangemouth's and BPOUK's trading arrangements sought to ensure that this potential for uncertainty was often expressed.

Database Reporting

Requirements for database reporting were defined relatively late in the implementation of RIS. Each of the BP programmers working on the project and systems staff in the wider BP Group with an interest in Grangemouth RIS, had their own "intuitive" views of what should be provided. There was however little agreement between these views and the diversity of reporting tastes within the group was reflected at different RIS implementations. For example..

> At Alliance refinery in New Orleans they ended up putting in a data capture system which was very reliable and they gave people facilities using Mac PC's. So they used the power of the Mac to allow people to do things like trending process data [and] extracting data into spreadsheets [5].

> Both Bulwer Island and Alliance gave some users access to the system prompt [Access to the "system prompt" entails the opportunity, but not necessarily the ability, to partially "write" the system as one's usage needs arise]. The intention is not to do that here [at Grangemouth] [10].

> At Rotterdam they drifted from the ideal of open access to the system prompt and instead used a number of pre-defined specific screens. Other refineries have started from Rotterdam's final model and moved back towards the ideal [For this programmer "open access" was seen to be the "ideal"] [10].

> At Alliance <u>ad hoc</u> reporting was question and answer based [4].

> Bulwer Island used general parameterised forms for reporting. So there were less forms than at Rotterdam, but they were more general [6].

> Gothenburg took an extract from their main database to a mini database on which users could write their own inquiries using the 20:20 spreadsheet package [10].

Thus, there was no general agreement within the BP group over how database reporting facilities should be provided. According to one of the system builders...

> The Management Steering Group either doesn't have a view on this, or if they have, I haven't found it yet [11].

Within Grangemouth refinery the system builders settled on a number of different approaches to satisfying users' reporting needs. The number of different approaches to reporting on the part of the system builders were accommodated through the provision of a number of different reporting routes. However, some views could not be accommodated "technologically".

> There's three groups: there's the standardised reporting screens; there are.. ones which have more flexibility; and really if none of them will suit, people will resort to the computer department [5].

These differences in approach reflected different conceptions and representations of the capabilities and requirements of refinery staff and managers. The "potential" of the technology employed was seen to interact with the competencies and wider context of refinery management. For example, a member of the BDU Systems Group who had been intimately involved with the development of the Rotterdam system and the early stages of the Grangemouth implementation, believed that whilst relational database technology provided a simpler and neater way of conveying information between subsystems than a hierarchical structure would allow, complications re-arose when the database was to be queried [6].

Managers were seen to be "too busy" to learn the skills required for sophisticated interrogation of the database, but they nevertheless wanted access to the sort of information such queries would provide. Whilst staff and some managers could, and did, use spreadsheets (for example at Gothenburg and later at Grangemouth) to manipulate data extracted from the database. They were not seen to be capable or willing to use 4th generation "natural" language tools to manipulate, and indeed extract, the information required. Hence the reluctance at Grangemouth to give users access to RIS at the system prompt level. Moreover, there was little experience at Grangemouth of natural language type interfaces, whereas Lotus spreadsheets were quite widely used [7].

> End users cannot use fourth generation languages. They need professional support both for security reasons and in terms of data definitions. There's no problem with simple systems but with larger scale systems the complexity of table linkages precludes their use by the non-expert [6].

Similar views were expressed by one of the system managers at Grangemouth with responsibility for RIS and the view was solidified in the database reporting made available at the refinery. Although predicting future demands for non standardised information, he saw little evidence of current expression of these demands.

> I always expected that the computer department would have to provide a facility where they would respond very quickly to particular queries. Nevertheless, I don't see any evidence of that sort of thing happening. I still expect it to happen. Once we've got all our data in the database I think managers are going to have need for ad hoc queries and they're not going to set these things up themselves [5].

Others noted the practical limitations of the tools provided.

> We have an ad hoc reporting facility with an interface to the Lotus spreadsheet package. In theory it should allow the user to write their own completely ad hoc query to download any available data into Lotus for spreadsheet analysis. In practice the download is being carried out either by RIS project staff or more recently, by the Computer Support Committee [4].

Lower level staff with more experience of spreadsheet usage may have been capable of producing the information they wanted using such simple tools, but they were not seen to be users of non-standardised information.

> I'm sure there'll be some [queries] that [managers] can't deal with. These facilities are still geared pretty much at looking at the raw data. They're going to have requirements which require a certain amount of processing of that raw data and I think that's going to require computer services.. I guess you can do virtually anything with a Lotus spreadsheet if you put the time into doing it, but a manager's not going to do that.. but I think for the majority of users those tools that we've provided should actually meet their needs [5].

Whilst the manager quoted above was "keen on ad hoc" facilities [3], they were seen to be "dangerous". He thought that they could be provided to "more sophisticated users" but that such users would still require a user support team to set up appropriate access to the database for them [3]. Another system builder..

> ..envisage[d] ad hocs actually being done by the users themselves, without recourse to applications support [4].

Although...

> One problem with this approach [to ad hoc querying] is that the size of the reports that can be generated by novice users could actually kill the machine [4].

However, one of the system builders who had worked at Bulwer and Alliance where access to the system prompt had been provided for users suggested that such "privileges" had not "significantly contributed to machine loading" [10]. There had been performance problems at Bulwer, as we noted earlier, but these were seen to be due to the rate of data capture and the complex design of planning and scheduling applications employed [10].

As we noted above, there was a perception of a potential future need for such information from higher management, but the remit of the RIS system was seen to limit the usefulness of the information available. RIS was seen to be of limited use for higher management since it only contained oil production data [3]. This data was primarily utilised to "set targets for the process units and send out instructions" with this information being communicated through the use of "standardised screens" [5]. The production of standardised screens to deliver pre-defined information for applications was where the "bulk" of the database reporting effort was required [5].

Cross referenced information emanating from more than one RIS subsystem and from other systems communicating with RIS, was provided by some standard screens, but this sort of information was not seen as "important" for refinery managers, its production was not "justified" [12]. RIS was seen as "just" an oil production planning system, access to, and combination with, other sources of information was not seen as important [12].

Higher management were not seen to be aware of what cross referenced information they required [12]. The "activity based" nature of the site meant that such information was seen to be required only in certain circumstances, for example, comparing relative performance against budgets, and standard reports were already available for such purposes [12]. More general information to assist in understanding wider, more fundamental questions, was not seen by management as appropriate to their roles and was, perhaps more importantly, explicitly outside the scope of the RIS system [12]. And the system builders were keen to retain this restricted scope: "..we've avoided looking for expansion" [5]. Strategic information for refinery management came from Head Office staff viewing trends to examine wider issues. Indeed, there was seen to be a very clear differentiation between the time frames of various activities, as opposed to other businesses, where the divisions between operations, tactics, and strategy were seen to be "largely arbitrary". This restricted view of managerial responsibility meant that aggregated, cross referenced information on wider issues was irrelevant to managers at Grangemouth [12].

Another concern was that users at the refinery were generally of "limited" computer experience.

> The users we targeted.. were the ones that worked with PC's normally.. because they were the type of people who were likely to need that sort of flexible facility [5].

There was little availability of PC's on the site until about five years before the implementation of RIS, and hence computing knowledge was mainly in the hands of people new to the site [11]. Reporting of the database in non-standardised form required quite detailed knowledge of relatively complicated Standard Query Language (SQL) programming. The example below, which displays a monthly salary bill for each department of an organisation, comes from the British Standards Institution's Specification for Database Language SQL (BS 6964: 1988):

```
SELECT DNAME, SUM (SAL) FROM EMP, DEPT
WHERE EMP.DEPTNO = DEPT.DEPTNO
GROUP BY DNAME;
```

However often unknown "experts" were thought to exist in certain departments, their expertise having been acquired through "hobby usage" [10]. As a result, one of the system managers with responsibility for RIS was, from his programming perspective, keen to allow such users access to the SQL system prompt to enable them to structure their own queries. "Hobby users" were seen by this builder as a potential resource that should be exploited.

> It makes things easier and allows them to do possible little odds and sods not anticipated in the programs [10].

Ironically, the limited scope of the RIS information was not seen by this manager to be a reason for not providing flexible access. Instead, RIS was seen to offer the potential of more open access than "most company information systems since it doesn't contain much sensitive information, particularly personnel files and payroll" [10]. He did however note that there were quite big differences between users "levels of imagination and realisation of the potential of the system" [10]. In his opinion, user imagination was the limiting factor, users seemed to "want to be told what the system would deliver" [10].

The "dangers" of such an open approach for the other system builders, coupled with a perceived lack of demand for such facilities at Grangemouth meant that this was not allowed to happen. This may reflect "protectionism" on the part of the designers, reflecting a very real fear that they could lose control of the system. And, as we hinted above, even the analysis of data downloaded by a support group was seen to be beyond the willingness and capabilities of management [7]. Trend analysis and the manipulation of RIS data using Lotus were seen "a more sort of advanced thing" [1] and, initially at least, these facilities were only made available to, and used by, key individuals, particularly technical specialists who were deemed to have the appropriate skills (see next chapter) [10]. At first the Lotus interface only allowed the download of data from "a single file" but a sandwich student working on the project "introduced the ability to download from multiple files" [4], although whether such direct access was available "in practice" remains unclear.

Opinions on appropriate reporting seemed to change throughout the implementation. One of the system builders had, at the feasibility stage, thought that.. "access to the SQL prompt was the best idea" [11] but as the implementation "proceeded and we realised the size of system and the potential complexity of reports" he decided to opt for the "same approach as Rotterdam and not allow such access" [11]. Not only were there doubts about the "overall business benefits", such complex inquiries were seen to require "programmers" and the training required to get general users to "this level of competency" was deemed to be "unjustified" [11]. Instead the refinery opted for a fast response (in the order of half an hour) to complex queries from the Computer Services Committee. Users had not previously approached the CSC with information requests "because of the slowness of response" [11]. As part of the general aim to encourage a more commercial orientation within the refinery, the CSC charged user departments for the time involved in answering such queries [11].

As some of the previous quotes suggest, it was also expected that user demands, expectations and ownership beliefs concerning information would change over time.

> When the feasibility study was first mooted we expected departmental managers not to be keen on open information. This is changing and now I think a request for any data would be seen as reasonable [7].

However, this spirit of openness was not quite all pervasive. Users in the Production Department were not keen on allowing Head Office users access to parts of the system that might contain provisional plans that had not been ratified. These concerns were seen to reflect a level of distrust between Head Office and Production Department staff. There was a great deal of overlap between their responsibilities and Production staff saw H.O.'s involvement as an unreasonable and unnecessary continual checking of their activities [10].

> Needless to say, Head Office people do not share this impression [10,13].

The users, use and type of information required of RIS was also expected to change. Whilst at present higher level managers saw little use for the system, some of their subordinates were extensive users. Thus the demands made of RIS were likely to change as those experienced users move up the organisational hierarchy and continued and expanded their use of the system [10,11].

In summary, these concerns and pressures resulted in the provision of <u>ad hoc</u> reporting through the use of SQL forms, written by support personnel, that took the form of menus. In some cases these menus could be parameterised by users, allowing them to select of subset of a pre-defined inquiry, to bring about the download of the data they required [1].

> We thought we could cover that [ad hoc reporting] by Lotus, "Trends" [a trending program, written at Rotterdam and picked up by Grangemouth] and tabular reporting of time against qualities.., any tank data, and some movement data [1].
>
> We decided that we would package the three of them into a user defined reporting set or group of facilities and we would standardise the interface to them so that the users used the three of them in the same way [5].

The facilities provided were seen to represent a balance between provision of pre-defined reporting formats to reflect and embody "business needs" deduced and constructed by the system builders in their discussions with users, and predicted and current user demands for ease of access to novel information. The forward looking orientation of RIS at Grangemouth was recognised to require some flexibility in the design of future reports. Lessons learnt from previous and ongoing RIS implementations were built into the system's reporting structures. And system builders were, on the whole, happy with their response to these demands.

> You can't afford to go to either extreme. And I think we've got the right balance here (laughter) [5].

In the next section, we examine how the realisation of the benefits that RIS was expected to provide was managed at Grangemouth.

Managing the Benefits of RIS

As we noted earlier in our account, obtaining ratification and funding for RIS type systems within the BP Group became "more difficult" in the period preceding and during the Grangemouth implementation as a result of the emergent "perception of failure" surrounding the first two implementations at Rotterdam and Bulwer Island [8]. Whilst these "failures" were primarily attributed to changes in environmental circumstances and technical difficulties respectively, the resulting increased reluctance on the part of senior managers to support large scale IS projects at refineries led to increased demands for the provision of systematic benefits management procedures on concurrent and subsequent projects of a similar nature. The key to successful benefits management was seen to lie in an early, systematic enrolment of the system's prospective users. One of the senior managers involved in the Rotterdam project, who was also a member of the Grangemouth Management Steering Committee, had this to say on the subject:

> I think the key thing is having solved the technical problems with putting the systems in, you then have a secondary problem in that if you don't use the system and.. the users, aren't committed to it, then you don't get the benefits. And that is one of the key problems that we're facing really.., bringing the users along with the implementation of the system and ensuring that they use it after the event [8].

The benefits management procedures employed at the Grangemouth implementation were exemplary in this respect. Although "a bit bureaucratic.. having seen the lack of enthusiasm, certainly in the Rotterdam refinery" it was seen as "important that" an attempt be made to "boost" enthusiasm early in the project [8].

> [One of the system managers] at Grangemouth has picked up on this point.. and he's actually generated some ideas on management of the benefits. And the way he approaches that is he actually allocates responsibility for recovering benefits to people who claimed for individual components of the system. He's aiming to delegate the responsibility and what he proposed is that as bits of the system are implemented they will be audited and what I've recommended is that twelve months after the completion of the whole system we audit it again, just to make sure [8].

Although coming late to such an orientation the system manager referred to in the above quote adopted the approach wholeheartedly. He saw future projects as insupportable in the absence of such procedures and spoke ruefully about the lateness of his conversion.

> In fact for any project coming along now I don't think it should be sanctioned unless they have a Benefits Management plan in place [5].
>
> It would have worked an awful lot better.. if I'd done benefits management procedures right at the beginning of the project when we were getting the thing authorised [5].

Concerns were, however expressed by the senior manager on the Grangemouth Management Steering Committee about the manageability of such an approach.

> Now whether, at the end of the day, that's actually a manageable thing, I don't know.. it's a step in the right direction [8].

And these concerns were reflected by the system builder at the refinery who proposed the approach. Coping with these complexities resulted in a questioning of extant refinery role allocations.

> If you take performance monitoring where one person is responsible for setting the targets and monitoring what's happened and another one is responsible for actually taking some action to improve things then it's a little bit difficult to see.. who's responsible for making the whole thing generate dollars at the end of the day [5].

Other organisational changes underway at the time of the implementation increased the visibility of these issues, and problems were exacerbated by the ephemeral nature of some of the benefits thought to accrue from the system and made particularly acute by the emerging commercial orientation that RIS was expected to play a role in delivering.

> Many of the benefits are cultural and although lots of them are measurable, they are very difficult to cost justify [4].

Nevertheless, despite the potential problems with the approach's application, benefits management at the refinery was seen to have furthered its cause. The uncertainty and impreciseness of the procedures were not perceived to undermine their effectiveness.

> The principle of using Benefits Management in order to make people think ahead about how they're going to use the system and what the implications are for their department has been really useful. Clear accountability is one part of it and can help. If you can get to the point where a person is responsible for producing a million dollars worth of benefit then it certainly helps to concentrate their mind a bit! (laughter) [5].

Before turning to consider less systematic methods of benefits accrual it is worth noting a minor controversy over the origin of the benefits management proposals discussed above. Whilst not disputing the effectiveness of the benefits management procedure, another systems manager at the refinery suggested that its instigation was not merely a particularly astute local reading of wider pressures. Head Office intervention to ensure that strategic concerns were not consumed by more pressing local "firefighting" was seen to be the <u>direct</u> driver behind RIS's benefits management system. The aims of the system and the mechanisms for their achievement were seen to be stabilised and maintained by the application of guidelines for development constructed at the group's corporate centre. These guidelines entailed the application of Benefits Management procedures to the project.

> It's been kept in my opinion relatively fixed because it really has had the full weight of BP's IS project management guidelines behind it.. Because of the background, refineries have been asked to act in by and large a reactive mode. And that basically means that maintenance always wins over development. Now the refinery has had, and will.. no doubt.. continue to have, its fair share of operational ups and downs and maintenance type priorities short term. And so what BP did is.. put down certain standards through its more centralised Head Office type functions.. and require, for example, the General Manager to chair a project board, it required one or two external appointees on that board, it required certain aspects like Benefits Management to be documented. In other words, it was assuring that the refinery would not let this development trickle between its fingers [2].

The belief that projects "should not be sanctioned unless they have a benefits management plan in place" [5] may simply have been a self sustaining reflection of one element of a set of directive "guidelines".

Ensuring Accrual of Less Specific Benefits

The SIS system that had been the pre-cursor of RIS at Rotterdam and had, in part, fabricated a need for RIS at that refinery, was designed to facilitate the traders' ability to trade. RIS was supposed to redress the resulting imbalance in power/knowledge and to provide a check on the traders activities.

> Clearly there's a certain amount of information the traders have to use, have to find, as part of their day to day business. If there is something extreme that needs some consideration and.. needs to be bounced off the refinery, instead of the refinery giving a seat of the pants answer which is what would happen

today, you have the opportunity to analyse the thing.. The short term you really have to still do.. seat of the pants but if you have.. half a day, one day to analyse then you can see what.. impact, let's say of bringing in crude in the middle of your existing schedule, will have on the refinery and put dollars and cents against it. So that maybe the trader's got a good deal at his end but if that's impacted on the optimisation of the refinery, you may have lost more at the refinery than the trader's gained at the other end.. I think the communication [at Rotterdam] was such that the trader believed he (sic) was getting a good deal and didn't worry too much about the refinery aspect. And it was always retrospective that they'd discover they'd lost money on the deal.. It just gives more power to the refinery's elbow [8].

To be able to use the system for such purposes required a system that was "bedded in" [8]. At Rotterdam this had not been allowed to happen and thus benefits had not accrued.

I think you have to go through a learning curve, you have to implement the system first, settle it down, get confidence in it and get sufficient speed really to be able to do such things. In the long term.. that would be the goal. I don't think we've achieved it to date [at Rotterdam] but that's not the system's fault. That is.. the circumstances surrounding the refinery.., the fact that we went into the joint venture and had to go back to square one [8].

Notwithstanding our earlier comments about the distrust that RIS information was seen to perpetuate between the Head Office and the Grangemouth Production Department, RIS was seen as a system that could break down such barriers.

I can only think that it can help the situation because the relevant data becomes visible to the Head Office and therefore points the refinery's putting across are visible to them as well [8].

These promised but unachieved benefits of Rotterdam RIS were again a desired outcome of the Grangemouth implementation. With regard to the refinery Head Office relationship, RIS information was seen to have enabled new accountabilities through the visibility it provided.

We're talking about a contract between the refinery and BP Oil Europe which details certain performance characteristics. Now that's not to say that the refinery's accountable for its bottom line full stop, because that's determined far too much by the market over which the refinery has precious little control. But concepts like "per cent of a theoretical refinery margin achieved" takes that market volatility out and starts to put [in] a more meaningful measure in terms of what the refinery has actually done [2].

Similarly, RIS information would provide benefits that cut across internal refinery boundaries.

I think over the course of time having a database of relevant oil type parameters for the refinery will provide a wealth of data [and hence] better understanding, better quality control of the manufacturing process [and] plant operations.. I think it offers the potential for a wider and better understanding.. RIS type information offers an opportunity to share, and if it shares in an environment and an atmosphere that is constructive then that augers well for the future [2].

We examine explicit attempts to create a "constructive environment" at the refinery and within the wider group in the epilogue. These attempts reflected a wider belief that the major blocks on the achievement of commercial advantage from RIS would not be technology based.

What are the barriers to use of information? Where does the responsibility lie? This type of information technology can channel that information theoretically, anywhere you like. So the bottleneck is likely to be organisational or quality [of] data rather than the structure or availability of information [2].

As we noted above, achievement of these latent benefits was expected to be particularly hard to quantify in the commercial terms of the orientation RIS was intended to engender.

The biggest difficulty of course is when you take advantage of some of these opportunities what is the difference worth compared to what you were doing before? And that measurement of change is notoriously difficult to actually get hold of [2].

Echoing the point made by the senior manager from the Management Steering Committee, the refinery manager quoted above saw opportunities for "risk management" benefits through the colonisation of the future that a forward looking RIS planning system provided.

> You take a calculated risk when you decide to fly or go by train or whatever. If you're very unlucky some of those risks will actually come home and you'll fail to make the journey on time, or whatever, and you take the consequences. We have the same issue in practice every day. Understanding the risks ought to be improved as a simple by-product of having this sort of system [2].

"Risk management" was seen to be particularly valuable when examining the risks of management processes. The refinery's adoption of the International Safety Ratings System, developed by the International Loss Control Institute, served to further sensitize the minds of managers to these issues.

> It [RIS information] actually gives you the opportunity to investigate and review not just the failure of equipment, which undoubtedly will last for as long as the place is here. It's also going to understand the risks of loss of management process and my bet is that the latter is by no means insignificant in comparison to the former. Technical breakdown can be very visible but behind quite often is something in terms of more deep lying management process. We do of course sometimes make mistakes, like getting the wrong component into the right tank, and that's got nothing to do with equipment. It is solely to do with quality of planning or implementation.. The question is, what do you do about it? [2].

RIS offered opportunities for a critical reassessment of activities and particularly their planning. Planning activities and improving planning procedures were seen to be the key to commercial success.

> I don't see how you can run this sort of outfit commercially effectively and in a competitive fashion if you cannot create an implementable plan [2].

The predictability of operations at the refinery, achieved through planning, was essential for integration of activities in the wider group.

> There is a team effort involved between the refinery and the rest of the company. It's not contributing very well to that team effort if it's not functioning in a predictable fashion.. If you can increase your certainty of operation you can reduce your insurance of stock holding under certain circumstances [2].

Other symptoms of unpredictable operations such as the distressed purchasing witnessed at Rotterdam could also be addressed. Although..

> Interestingly enough that particular performance measure.. I suspect comes through in terms of the traders' performance [and] doesn't actually show up as a blot on the refinery or on the [H.O.] supply organisation sitting between the refinery and its markets [2].

However, the integration of activities that shared information was seen to enable, subject to the wider commercial orientation that RIS was seen to engender, meant that the parochialism that the above quote suggests was not seen to achieve expression in activities.

> At the end of the day the shareholder is not in the slightest bit interested in a squabble between the traders and the refinery.. So there's a number of areas outside the refining box itself, within the total oil business, which would benefit [2].

This shift in orientation was also predicated on other organisational initiatives that are briefly considered in the epilogue.

Thus the "technology", at least at Grangemouth, was not seen to be the constraint on the accrual of benefits from the system. Getting organisational commitment to RIS in the early stages of its implementation was particularly problematic.

> There is a problem with the users lack of widescale awareness of the system. It's very difficult to do much about this at the moment as so little is actually available to the users. There is a recognition that RIS will have to be sold. Most people don't know anything about RIS and don't see much benefit [4].

Specific, easily quantifiable benefits could be managed through the application of systematic benefits management procedures. Users who had been seconded onto the project and socialised into its objectives and methods were not seen to be the problem.

> The reaction so far from people who have been brought into the project has been very positive, so I see awareness of RIS as the main problem we have to overcome [4].

But awareness was also seen to be interrelated with usability. Given limited awareness the system had to reinforce itself early in the hearts and minds of the users through the ease of use and consequent organisational success it offered. Thus, although organisational factors were seen to provide the major stumbling blocks to a successful implementation, their complementarity with the system created a responsibility for future usage that was seen by the system builders to rest on their shoulders.

> My big worries are about the specifics of the usability of the system. In one sense if the system's not used it's seen as our fault for not providing the right product. So it's our responsibility, of course working with other managers throughout the site, to get it right and sell it to the users [4].

And enrolment through training and insistence on users providing and accepting specifications for elements of the system in their areas, were the keys to fulfilling this responsibility. Seconded users were also to act as Trojan horses in their departments in the battle to gain user acceptance and commitment to the system.

> We insisted upon the users coming along to provide acceptance of plans and we tried to get that on board at an early stage. I think.. the fact that we've had one or two people working with the team.. was very important. That's been very good [1].

This insistence was timetabled and proceduralised and hence fed back from the users in the form of tighter demands on the system builders.

> We're also trying to get the users to know in advance precisely when they will be required to be inputting specifications. So there's a bit more pressure on us to try and achieve those deadlines, all well and good I guess, but it means that we can help the users have a bit more opportunity to schedule their work round when we need them [1].

This proceduralisation was a response to particular concerns surrounding user involvement in a number of departments whose commitment to the system was seen to be paramount to a successful implementation. For example, in the Production Department..

> The biggest problem they've had is simply the availability of staff for training which means they're still dependent on one or two individuals [to operate the system].. That's really just down to staff holidays and the limited number of staff available in production [1].

The lack of time available for training meant enrolment through specification and testing became all the more important. The problems were exacerbated by some of the other organisational changes underway at the refinery that are discussed in the epilogue.

> Several of the key people who we want to do testing and things like that on RIS are also the key people who are involved in those other projects... It's meant a bit more effort and it's meant a bit of frustration I think, more within the team than anything else. Because they've worked extremely hard and then to sit down and see.. not to see the users letting them down somehow, because they appreciate the users have other jobs to do as well, but it can be a bit frustrating when you're working long hours and the user staff just aren't available to follow up the work you're doing.. but there's certainly no ill feeling between the users and the team [1].

Thus although bedding the system down with the users was seen to be fraught with difficulties, the system builders were convinced that this aspect of the project was proceeding as successfully as circumstances would allow. And other socialisation processes were seen to be both enabling and exemplifying this belief.

> We had a team party to celebrate the system going in and we invited a lot of users along to that. We actually invited something in the region of twenty odd users I think, quite a considerable proportion of whom did come along. So again, I think that shows there's certainly a good rapport I think between the team and the users [1].

In the next chapter we examine the user response and reactions to RIS.

NOTES AND REFERENCES

1. Interview: Systems Manager 3 (Grangemouth Refinery) 2nd Interview 17th July 1991.

2. Interview: Systems Manager 1 (Grangemouth Refinery) 1st Interview 14th October 1991.

3. Interview: Systems Manager 2 (Grangemouth Refinery) 1st Interview 29th November 1990.

4. Interview: Systems Manager 3 (Grangemouth Refinery) 1st Interview 18th April 1991.

5. Interview: Systems Manager 2 (Grangemouth Refinery) 3rd Interview 7th November 1991.

6. Interview: Senior Manager in Systems Group of Manufacturing and Supply Business Development Unit, BPOI Corporate Centre, London. 25th March 1991.

7. Interview: Systems Manager 2 (Grangemouth Refinery) 2nd Interview 9th April 1991.

8. Interview: European Refinery Analyst, Manufacturing Development Group, BP Oil Europe, (at BPOUK H.Q. Hemel Hempstead) 7th June 1991.

9. Interview: Systems Manager 1 (Grangemouth Refinery) 2nd Interview 7th November 1991.

10. Interview: Systems Manager 4 (Grangemouth Refinery) 1st Interview 10th May 1991.

11. Brief Conversation with System Manager 2 (Grangemouth Refinery) 10th May 1991.

12. Brief Conversation with System Manager 1 (Grangemouth Refinery) 27th November 1991.

13. The overlapping responsibilities and distrust were addressed by an organisational review that was outside the scope of RIS.

CHAPTER NINE

USING THE SYSTEM AT GRANGEMOUTH

Introduction

As RIS was introduced as a "phased development" it was impossible for the researcher, in the time available, to examine overall user involvement in, and acceptance of, the RIS development. Indeed, it is important to note that the characteristics of the system described in this research are not necessarily those of the "final" form of RIS at Grangemouth. As we have seen in earlier chapters, RIS is a contingent, mobile and transient system that has changed, in some cases beyond recognition, throughout its development and dispersal. It will no doubt have changed again before a "final" version of the system is deemed to have been built at Grangemouth and will probably continue to change throughout its "useful" life.

The following is a collection of some early accounts of experience of RIS provided by some of the key refinery users. It is however important to note that the profile and size of the user group was expected to change quite significantly during and after the implementation as more data became available, and more "informing" applications were developed. As we noted in the previous chapter, despite the overarching commercial information orientation of RIS, these applications were deemed to be the most difficult to provide.

Enrolling the Users in Joint Application Development (JAD)

Joint Application Development (JAD) was seen by the authors of the Feasibility Study to be the only route to follow for a successful implementation of RIS at Grangemouth.

> There is only one realistic development approach for the Grangemouth RIS system. This is the approach variously known as "end-user computing", "user-led computing", or - our preferred term - "Joint Application Development" [1].

We noted in an earlier chapter how many of the demands of JAD were not met as it was felt that they had been adequately dealt with at previous implementations. In this section we examine the users' accounts of their involvement in the JAD that did occur at Grangemouth.

Enrolment of users in the development of RIS took a number of different forms. These included secondment of "key" users onto the System Design Team; requiring users to assist in the production of application specification and acceptance; and training. Seconded "users" came from two main sources: staff from departments expected to be major users in the future, particularly the Production Programming Department; and staff from the Computer Services Committee (CSC) who were expected to support the system and its wider user group in the longer term.

> In terms of longer term support, we're trying to build up a team there in application support.. and actually one of the users complimented us last night, he said he thought that was good, that somebody who had some confidence and who'd worked on the system had gone back to CSC and was going to support it. By the end of the project there should be four people in CSC who've worked in the sort of development and have a reasonably good feel for the system. I mean it's very difficult with a system as complicated as RIS for four people to know everything there is to

know but we are trying to make sure it's not a question of the project team walking out and leaving an unsupportable system there [2].

There'll be something in the region of a dozen people I guess who've worked with the RIS system quite closely staying on.. The users, the three or four users.. will go back to their various departments.. Scicon come along with the technical skills, the actual information systems skills, and also with the experience of what they've done with implementing RIS's in other refineries and Grangemouth is providing.. primarily the user expertise, the local expertise, but also the people to support the system in the longer term [2].

Enrolment of staff from Production Programming, which encompasses both Production Planning and Scheduling, was particularly problematic. Not only was this department seen to be one of the key users of RIS, it was, after all, an "oil management system", it also had the greatest problems associated with staff availability for involvement in the development. One of the department's senior production planners expressed concerns about this issue, as did a number of the system builders.

I would've preferred the production programming team to have been strengthened before the implementation in order to allow some slack of experienced staff to liaise with the RIS team over our requirements.. Production programming has very few experienced staff due to the excessive staff turnover in the department. The staff we have are able to do the job adequately but they lack the broad depth of knowledge needed to look over the fence and beyond the immediate job [3].

These problems were exacerbated, as we noted in the previous section, by other ongoing organisational initiatives that produced their own demands on the time of key refinery personnel. Again, this problem was particularly pronounced in the Production Programming Department. As one of the system builders noted:

> One of the problems is that people have been writing a lot of procedures and RIS doesn't necessarily come top of the list for it. So we have had problems, particularly again with Production Department, with staff availability to write the new procedures [2].

The senior production planner, quoted above, wanted to work with the RIS team himself, since he was "very aware that involvement is important is identifying possible appropriate solutions." If the promised commercial benefits were to be achieved, "the tool must be usable" [3]. Staffing pressures meant that instead he was forced to accept the involvement of a more junior member of his department with the team. Other commitments conspired to ensure that this junior planner "was not exactly keen" [3]. The exigencies of his routine tasks cast involvement with the RIS team as an unnecessary luxury that the department could not really afford. However, for the system builders, the secondment of a relatively inexperienced user was seen to provide distinct advantages. Other, more senior, production planners had previously been involved with the team building the system, which was "excellent from the point of view of understanding what [the production programming tools] mean" but..

> we felt we needed a different outlook.. He's less experienced so he may well have requirements which [an experienced production person] doesn't have. I think it will be very useful having him on board.. There are things that, if you're new to the.. job you might want: information, assistance, help, which somebody who's got a lot of experience doesn't need. He know's it [2].

Thus, the exigencies of ongoing "routine" refinery activities necessitated the involvement of inexperienced personnel with the builders. However, as a result, the system could be better adapted to the needs of less experienced personnel who tended to populate a key department with an acute staff turnover problem. A staffing problem was translated into a partial technological fix.

Enrolling Non-Users

The enrolment of other key staff from a very different part of the organisation was also problematic. Whilst not seen to be important users of the system, the operators of the plant, particularly in the blending areas of "the off-site tank farm", had an important role to play in the provision and maintenance of the data upon which RIS was to depend. An interesting tension developed here between the remit of the system and the demands of this group of employees whose co-operation was essential for a successful implementation. These concerns extended beyond the immediate offsites personnel. As another of the senior production programmers noted:

> RIS is quite a flexible system but we would have perhaps preferred a rather broader scope for the development. The problem, as always, is the allocation of funds. For example, offsites activities in this refinery involve many man hours of operations. RIS would've been a good opportunity to completely automate these processes, and perhaps that should've been done. But the costs in terms of machinery are probably high whilst offsites employees are relatively cheap. When you implement new tools for production programming they are less costly since much of the information is already there, you're not automating from scratch. And the benefits are bigger because we plan the entire site's production [4].

This point is exemplified from the perspective of one of the offsites operators.

> We were involved in consultation over RIS, but it was clear quite early on what we weren't going to get. We had hoped for an advanced measurement and control system. Due to the high costs involved, this was not forthcoming. It was made plain to us that the only data that would be available would be from the existing Whessomatic ATG [Automatic Tank Gauging System]. Offsites is very much under manual control which is potentially problematic. There's scope for a lot of errors and quite a few occur! [5].

Prior to the RIS development the blending area on the tank farm had been managed through a "fragmented system of operator knowledge, paper records, pro-forma sheets and big books" [5]. Whilst about 90% of the measurement of tank contents and product movements was automated there was little or no automated control of those tanks and the movements between them. Each tank was, and is, individually, manually controlled [5]. It would seem as if the proposals in the Feasibility Study for improvements to the blending area did not reach fruition.

In the absence of the sort of system they required to support their tasks, the system builders had a difficult task enrolling these relatively low status, low paid, offsites operators who nevertheless had an important role to play in the RIS development. The comments of an oil accountant at the refinery illustrate the lowly status accorded to "off-site" personnel by those in the core of the refinery. Although seeing the advantages of providing access to the COMA system (the Computerised Oil Management Accounting system that was to interface with RIS) to those working at the rail head on the dispatch of products by train, he did not envisage this access as being direct.

> I'd like to see a side package for the boys at the rail head which mirrors COMA. You couldn't give them access to COMA directly, it would be too dangerous, they'd wreck it! [6].

The proposed Movements Monitoring System RIS Application required offsites personnel to manually record valve statuses [5]. According to one of the offsites operators:

> One of the pre-conditions for RIS was that it shouldn't increase operator workload. As a sweetener offsites will be provided with reports associated with the start and end of movements information. This should increase reliability as these reports are currently done manually by the operators [5].

The system builders were obviously aware of these issues, but render them in rather different ways. The problem was seen to be one of perception and the seconded "user" from the tank farm was expected to act as a Trojan horse, re-engineering his colleagues resistance or apathy towards the system into support for "their" new "tool".

> We've got a chap from our tank area in as well who's looking at [the Movements Monitoring System] from the user point of view and he's starting to build up the maps and so on. And once he's done some work on those lines he will get the operators involved and try to build up some enthusiasm. I think that's going to be the key part there, getting the operators interested, convincing them that it really is useful to them.. One of the functions of the system is to capture in the database everything that happens in the tank farm area, so.. they need to use the system. We're designing it so that they don't have to put in a lot of manual data, but they do have to confirm that things are happening, they have to accept warnings. [Interviewer: So they are still involved in populating that database?] That's right, although that shouldn't be obvious to them. They should perceive it as a tool, purely to help them [7].

Thus we can see how a tension developed between RIS's objectives: to support oil management activities; to meet the users' "needs"; and to deliver a commercial advantage. RIS could not after all extend its purview to encompass automation of antiquated elements of the refinery system in order to facilitate more remote and immediate oil management operations. The labour to be replaced by such a move was too cheap to warrant it. Automation was not seen to be commercially viable. This, as we noted, created particular problems for the system builders in their attempts to portray themselves as the partners of the refinery users, seeking to create a system servant to satisfy their future needs. Indeed it reveals the extent to which a particular form of JAD was seen to be the only "realistic development approach" for Grangemouth RIS.

Users had to be enrolled but not necessarily satisfied. User satisfaction was secondary to the overall aim of the delivery of a commercial advantage through a colonisation of the future, and was certainly a minor consideration in terms of shorter term cost considerations. Commercial advantage and user acceptance could be gained by giving users "what they wanted", but this was not necessarily the only route to such an end. Rather, users had to be enrolled, or configured [8], to ensure the success of the system, and that success was to be measured in terms of its implications for the refinery's bottom line, the value it could add. Users were, as we noted earlier, not "expert" enough to know what they wanted. What they "really" wanted, as the system builders "knew" only too well, was a relatively cheap technological fix to ensure the future generation of "value". As we saw in the previous section systems staff saw a "need to adjust human resources to technical capabilities" and indeed, to the demands of a commercially successful future [9].

This orientation is most pronounced in the comments of one of the system builders who indicted the inadequacies of the reporting approach adopted at Alliance refinery in the U.S.A. where a simple database was produced that..

> ..used the power of Mac [Apple Macintosh] to allow people to do things like trending data, extracting data into spreadsheets, and they're the things we've done with user-defined reporting screens.. Now I think that's a little bit dangerous [7].

> They saw the weakness of [an overstructured approach at Rotterdam] and they wanted to provide something which was what the users wanted. And I think it shows the dangers of going too far in that direction. You know, what they ended up with [was] they implemented a nice, neat, tidy, simple data capture system using Setcon as a process database and they brought the data from Setcon into the RIS database at hourly intervals. So they took a lot of the loading off the machine by reducing the frequency of the data capture. And they've got a nice reliable data capture system because they've implemented all that, but because they channelled their efforts into making it nice and friendly for the users to use process data, they haven't really thought about what other kinds of data they want. They haven't thought about business need. At the end of the day, all they've got is data and a way to look at it [7].

> You can't afford to go to either extreme, and I think we've got the right balance here (laughter). [But] when you show it [the Grangemouth RIS reporting system] for the first time to users they don't open their mouths in awe, like you know, they do with the Apple Mac. The user response to the Apple Mac was incredible. It's seldom I've seen a demonstration of something to users where they've all sort of grasped it straight away, and said "Oh, we want this!" you know, "This is fabulous!" [7].

Users may have thought the system was "fabulous", and they may have "wanted" it, but it did not constitute a satisfaction of user needs. User "needs" were defined by their positioning in the overall refinery production network and the roles ascribed to them by the demands of a commercially oriented future. And only the business and systems analysts who made up the system design team had the appropriate expertise to arbitrate on what those needs were and how, in the final analysis, they were to be satisfied.

The Nature and Quality of RIS's Data, Information and Users

As one of the systems staff at Grangemouth noted:

> The bottleneck is likely to be organisational or quality [of] data rather than the structure or availability of information [9].

In this section we consider users concerns surrounding issues of the quality of data and the structure and availability of information. Explicit attempts to remove organisational "barriers" are briefly considered in the epilogue to our account.

A number of the RIS system's actual and potential users raised the issue of the quality of the data on which RIS was to depend. RIS was seen as a response to both the inadequate commercial use of already available data and the adequacy of the data that was available for translation for such purposes. The latter concern was simultaneously seen to be both more fundamental and something of a secondary issue. For example, one of the senior production programmers noted that some of the tank dipping equipment, that provided information on tank contents, had been producing "bad" readings which could potentially cause problems [3]. According to a member of the refinery's Reliability and Loss Control Group:

> The RIS system is only as good as the ATG [Automatic Tank Gauging System] on which it is based. There are 130 ATG's on the refinery and maintenance of them is virtually a full time job for at least one engineer. At present we have customs approval [as providers of information for the allocation of duty] for about 100. 13 are not in service and we are attempting to gain approval for 17 of them. Nothing measured on them is acceptable for customs [10].

Moreover, 10% of tank readings were manually produced and these readings were seen to be particularly dubious.

Systematised automated dipping is more reliable than manual. Dips that are different will not be different purely as a result of operators' different dipping techniques [10].

Whilst it was pointed out that "this had always been the case" [3] production programmers felt that RIS had increased visibility and hence awareness of the problem. It was seen to be essential that all the data picked up by RIS could be relied upon with a high degree of certainty.

Otherwise people will lose faith in the system. I cannot overemphasise the importance of confidence in the data provided [3].

I foresee the major issues being ensuring the reliability and validity of the system [11].

Another user who was involved in Oil Accounting at the refinery pointed out this general problem with the data and information generated on the site. Although "ideally" he wanted "RIS to automate everything" the reliability and validity of the information provided on site served to make this impossible.

The complexity of the site makes the checking of the reasonableness of information by Oil Accountants very difficult. We have no idea whether the information with which we are provided is accurate [6].

The maintenance issues, briefly raised above, were seen to have important wider causes and implications. As we noted in an earlier section considering the importance of Benefits Management procedures at the refinery...

Because of the background, refineries have been asked to act in by and large a reactive mode. And that basically means that maintenance always wins over development [7].

But priorities within the maintenance schedule were also seen to be important for maintaining the reliability of RIS information.

> We have had to fight fairly hard to get sufficient manpower to maintain the system. Work is done on a priority system on other parts of the site. These [RIS information] priorities are not as high for fitters who don't require the information the system provides and more particularly for their managers who set the priorities. It's easier to see a plant component broken rather than to notice information providing equipment that isn't working.. Maintenance managers need education and time to see the benefits of the system. Possibly, in the future, we should move towards more technically oriented people working on maintaining the equipment and that might also allow some savings in the number of employees we require. But it's difficult for our present fitters to see that more information is pretty much always better [10].

Confidence in RIS's information was also seen to effect usability. Again a compromise had to be made.

> The tool must be usable and it maybe that we have to sacrifice some accuracy for expediency, i.e. ease of use. Although hopefully this won't be the case [3].

As we noted in the previous chapter choices over what data should be captured and at what level of resolution they should be recorded reflected wider concerns of the overall purpose of RIS, the limitations of the "technology", the usability of the "technology", and the usefulness of the information it provided.

> There was a compromise made as to the number of operational data collection points out of that mass of ironwork out there on the refinery that would be collated for production planning purposes [9].

Thus the structuring of information was also effected by concerns about the quality of the data upon which RIS depended. RIS's recursive use of information in a number of different applications placed the technical "quality" of the system and its usability in a competition for attention throughout the development. There was a huge potential for the magnification of small errors as information was aggregrated through a variety of seriated application programmes.

User Views on the Structure and Presentation of RIS Information

Information, as opposed to data, was deemed to be that which was imbued with usefulness through processing with reference to technical, business, and ideally commercial objectives. Issues surrounding RIS information thus pertain to the manipulation and aggregration of data and the modes of presentation of the results of such activities.

For the production programmers the information provided by the RIS system was generally "what was required" [12]. There was agreement in the department that RIS represented a major step forward from the previous system support that was available [13].

> The system gives you the information you use [14].
>
> Our systems used to be like an old clapped out mini. RIS is like a Golf GTi in comparison. The expenditure needed to produce a Rolls Royce is just not justifiable. On the whole, we're happy with the Golf [13].

Users were not, however, uncritical of the facilities provided and indeed, as we noted above, of the information those facilities were intended to manipulate.

> Costing in this place is a cock up and needs a damn good shake up [13].

Other concerns cut across the largely metaphorical divisions between system, information and data. Problems were noted but not attributed to any particular locus. Indeed as the quote below suggests, errors multiplied across these three regions and were often inseparable. Work was required on the part of the users to undo the damaging results of these cumulative perturbances of refining "reality".

> You need to take a big pinch of salt with the [LP] models [of the refinery and the various pieces of plant that make up the whole system]. It takes a lot of effort sometimes to make sure that the various management reports bear at least some relation to each other [14].

Certain functions available on the system were considered to be "next to useless" [13]. For example the information on the qualities of refining components and products only identified whether the substance was on or off specification. Users were given no indication of how much over spec. the product may be [12,13]. Such a deficiency is particularly glaring when viewed in relation to the commercial orientation RIS was intended to engender.

> If it's too good a mix we could be losing profit [13].

In the words of a member of the Head Office supply team:

> The main thing is to know what the current qualities are so that we can communicate them to the traders and they can then make the best use of them. I mean if we don't have access to the quality then we have to say to the traders that this is our normal but we can only guarantee a fairly low level of quality. So it's higher than we would've hoped to sell for the price we can ask for the worst 10%, or whatever. If we can get access to actual qualities then we can get a better guarantee and therefore maximise the profitability, the sale value [15].

Other concerns were raised about the data on product quality that was produced by the laboratory based RIS subsystem. Users had to "hunt" [13] for reports, there was no indication given on the system that updated qualities were available [12]. A delay was introduced in the availability of this information since "all the tests are done before the results are produced" [12]. Similarly, production programmers were not entirely satisfied with the wider reporting facilities provide. Retrieving things did not seem "natural" and finding things was "troublesome" [16].

> I'd like some highlighting when I log in, you know, for exception reports. I know these facilities won't help in spotting trends but I don't want to have to check everything every time I use the system [13].

Similar concerns were raised about the adequacy of the trending facilities provided in the database reporting package. Again, a diversity of views is apparent. For some users trending was not something they expected to find "useful" although when the facilities were provided uses were found for them [14]. Other users who were initially keener on the provision of trending facilities pointed to inadequacies in the nature of those facilities [16]. For example, one of the senior process engineers in the refinery noted that..

> RIS trending <u>has</u> to be against time and that's not always the resource required for process engineering. A process engineer often needs to compare two different data sources and examine the trends in their co-variation [emphasis in original] [17].

Others noted inadequacies that pertained to the presentation of information through the trending system, rather than to the functionality of that system [16], although these differences are probably more usefully considered as a matter of degree. One of the

Head Office Supply Department users indicted the presentation of database reports on a number of counts and recalls a conversation with one of the system builders concerning these problems.

> We talked about the layout of the reports, how appalling they looked. In 1991 we should be able to present a better style of screen than some boring set of green numbers on a black background. I mean you want some graphics, or something flashing, something which brings your attention to something, to the most critical area. A bit more imaginative than what they are now.. It should be user encouraging and friendly and enticing. I mean I think the way the trending system presents its graphs is very poor. Have you seen them? You get no y axis, and if you've got four graphs in one you have to look down the bottom at this minute print which tells you that they're all on a different basis. So even if you've got four straight lines running along together you can't read those.. as telling you.. that they're all at the same level because they're different scales. It's terribly confusing. I mean you can manually alter it but it takes you a further five minutes to reconfigure it, to read on the scale you want it to read. I mean once you've seen it and you logoff and you come back in the next day you've got to re-set that up. You've got to change it from auto to manual, you've got to change the minimum and maximum, and even then.. it won't write on the side of the y axis what it is. I think it's just that the graphs are so badly presented and unfriendly, but they've got a bit of colour on them I suppose [15].

These issues again lead us back to consideration of the relationship between the system builders and the users of the system. Providing "what the users want" was by no means unproblematic.

Configuring the Users' Requirements

There was a fundamental uncertainty within the refinery and the wider BP group concerning what the users' requirements were, and how they should be satisfied. We examined the views of the system builders on this issue in the preceding chapter. Overall, there was no more consistency between the users' views than there was between the formers'. A member of the lab with responsibility for the development of RIS's laboratory subsystem summed up the general problem as he saw it:

> There's a huge potential for communication problems between application development and the lab staff. The lab can't say what they want in terms of IT support and IT can't explain the use of their services to laboratory staff [18].

Some users did not see the responsibility for the provision of appropriate usable information as lying with them. For example, a member of the Reliability and Loss Control Group had this to say on the matter:

> All the information is in RIS, it just needs to be all pulled together. I see that as the responsibility of the programmers in the RIS team: to increase the usefulness of the information by actually calculating the specific information that Measurement and Loss Control requires. We don't have sufficient computing expertise and time constraints on us mean we can't do it ourselves. After, it's not the job of the Measurement and Loss Control Department to write programs [10].

There is a stark contrast here with the comments provided by the system builders. Whilst the majority of them agreed that they were the only ones with sufficient computer expertise to write programs, they saw the block on the successful achievement of this objective to be the users' inability to know what they wanted. This did provide them with opportunities to use their experience to colonise the definition and provision of future business requirements and hence future users, but big gaps were pointed to between users' "levels of imagination and realisation of the potential of the system" [19]. Other users had very different views. Those who were computer literate, particularly those in process engineering, seemed to resent attempts to closely pre-empt their specific information needs with the system. They wanted access to RIS information on their own terms and were particularly unhappy about the prospect of having to go through an application support department to get it.

> We were offered the ability to transfer data direct from RIS to Lotus for analysis. I say offered, but staff from this department were pushing hard for such facilities.. Although we're not all programmers in the technical department the majority of us are basically computer literate and therefore sophisticated users by the standards of this place. We see this sort of access as the only sensible route.. What we're aiming for is a parameterised download of RIS information via an on-screen menu. Ideally we want to maximise use by the user with the minimum involvement of user support.. There shouldn't be any need for us to seek application support. It basically just slows us down and we're capable of the majority of the tasks required. Our only real problems come if we actually need to change the SQL source code [17].

The Lotus download function was seen to have been "configured to be as flexible as possible" but users in the technical department were keen to see moves underway to "make it even more so" [17]. Here we see another group of users who certainly don't want to be told what they want.

We can see here again how claims to expertise facilitated power and enabled the definition of current and future user requirements, their satisfaction, and hence through reflection in the "mirror" of representation, the pre-definition of future users. In the following section we examine the orientation of the application support department and users' views on the training provided to facilitate a smooth integration of RIS usage into refinery activities.

Training and Application Support

Views on the adequacy of the training provided for effective RIS utilisation varied both between individual users and over time. As we noted in the previous chapter, the system builders described their later attempts at training provision as having gone "really well" [7]. This stands in stark contrast to the comments provided by users on the training made available to them when a limited set of RIS information first became available. One senior member of the production programming department described the initial training simply as "Crap!" [13]. As a result the system was not, at first, utilised by staff in production programming. These concerns reflected and extended opinions on the nature of the system's provisions and its ability to satisfy users' needs. The system's lack of ease of use increased the perceived need for training on appropriate and effective usage patterns. Organisational issues again exacerbated the problem. Users had little time to "play" with the system to try to ameliorate for the inadequacies of the training provision by discovering the system's capabilities and behaviour for themselves.

> But that's what you'd expect. This isn't a professional company. This is Mickey Mouse Oil! [13].

The perceived inadequacy of training, coupled with the desire to restrict direct access to novel RIS information to a few key users, led to a heightened importance for application support in the achievement of a successful implementation. Political battles over the importance of RIS type projects had not gone away, and senior refinery staff were acutely aware that RIS at Grangemouth had to prove itself.

> The system must, in the final analysis, be used.. I have no doubt that the RIS system will do all the things it should, although I do still have some doubts particularly with regard to whether or not the potential benefits are realised in practice, and more particularly, that they are seen to be realised [11].

At the end of phase 2 of the RIS development, in June/July 1991, ownership of the LP models utilised in RIS passed to the Production Programming Department whilst responsibility for the wider computing side of the system passed to the Computer Services Committee [4]. As we noted earlier, four members of the CSC had worked as part of the RIS team during the earlier stages of building the system [2,20].

The CSC team responsible for RIS provided and fulfilled a number of services and roles within the refinery. They solved users' problems regarding access to RIS data (often the problem was that the data was not yet on RIS); they sorted out users' difficulties with using RIS's interface screens; they maintained and provided software that allowed the downloading of RIS data for Lotus analysis; and they carried out general use monitoring and checking of data integrity [20].

The CSC support team can be seen to take a median view towards RIS and the satisfaction of user needs between those of the system builders and those of the actual users. They were keen on facilitating relatively free and open access to RIS information for more expert users, but were also cognizant of the "dangers" of such an approach. These dangers were not however seen to be as significant as some of the system builders had suggested.

> Even if the process engineers do manage to create a query that would seriously effect other users, it would only be for a very short duration. It is very unlikely that the mis-entering of download parameters would cause a serious problem. They are more likely just to get rubbish or get logged off [20].

Even less experienced users could be granted such access for a one off enquiry, although such access would itself only be provided as a "one off". The favoured approach of the CSC was to maintain some control and knowledge of usage by providing user departments with a..

> wide ranging generalised report. Individual department members will then be able to pick and choose from this data set to meet their particular needs [20].

Requirements for such facilities were expected to increase as more data became available on the system. At the time of interviewing, data available tended to be restricted to a specialised focus on either tank or lab data. As we noted in the previous chapter, although downloads from multiple files were theoretically possible, such access was not, in the spring of 1991, practically attainable without recourse to application support [21].

The CSC instituted a "Help Desk" to act as a filter between users and the "CSC proper" [20]. Telephonists logged users' queries about the system onto a computerised list that the CSC then worked through, providing answers and solutions to users when and where this was "possible" [20]. The CSC "advised" users and user departments on whether or not their request necessitated the introduction of re-usable access facilities or could be met by a one off report provided by CSC programming staff. User departments were charged for the provision of such services, as we noted in the previous chapter.

The CSC's role of user helper shared certain characteristics with the "nanny" state and this orientation is in line with the wider view of users held by systems staff at the refinery. For example, the CSC could and would reject requests from users for a re-usable interface if they thought it more advisable and cost effective to seek wider support for such usage and introduce the sort of access require as part of a more generally available, standard reporting route [20].

In all instances maintaining the integrity of the system was seen by by the CSC to be their core responsibility. For example "bugs" on the system discovered by the users were attended to "A.S.A.P.". The CSC was, after all, a <u>Computer</u> Support Committee, not a <u>user</u> support function.

This final point heightens an interesting difference in the relative power associated with the two groups of organisational participants who had more or less direct dealings with the RIS system: the users and the computing specialists who built and maintained the system. Whilst the latter group had a relatively wide knowledge of the system and could claim far reaching expertise, the former tended to only have experience of, and hence authority to speak about, an isolated portion of the overall system. As a member of the Reliability and Loss Control Department put it:

> Everybody tends to use a small part of the system and I suppose that potentially that's a bad thing. It can lead to blinkering on the part of the users. There's a very clear distinction between the users and the system analysts. The system analysts write the systems and they grow like great monoliths with no one person using more than a very selective part of the system [10].

Thus again we see the emergence of the problem of competing local and wider concerns. In the last section in this chapter we go on to examine how the users invoked their own conceptions of the wider refinery production system in an attempt to contextualise and hence control their relations with the emerging "monolithic" RIS system which sought to enrol them.

Precedent, Practice and Practicalities

Users at Grangemouth had managed oil production at the refinery for many years prior to the introduction of the RIS system. They had used various sources of information and expertise, and had, by all accounts, been relatively successful in their endeavours. The refinery's geographical location and its links to the Forties pipeline made it a strategically important site in the UK and this must have contributed to the decision in the eighties to keep Grangemouth as the only major BP refinery in the UK. However, one would imagine that its past and future value added performance must have been seen to be at least satisfactory for such a decision to be taken.

Users at the refinery, particularly those users in the production programming department, could lay claim to expertise in the oil management of the site. And this expertise was not predicated on the existence of the RIS system but on other prior techniques of production management and control. This provided prospective users with a potent resource upon which to draw in the struggle to establish new roles and understandings of their activities in the face of the emerging RIS system.

We noted earlier that the general orientation of the system builders in their provision of user services was to..

> give people as much information as they need to do their job, without trying to do the job for them [2].

RIS was seen to be an information system, not an automation of refinery processes, and in such circumstances precedentially sanctioned understandings and methods of working could conspire to circumvent the use of RIS, at least to a certain extent. RIS data and information was recognised as being partially remote from refining "reality", as it was defined by Grangemouth staff, and human involvement [14] was deemed to be essential for the prevention of reification of the system's somewhat dubious representations. Acting blinkeredly on the recommendations of reified computer based models of reality was seen to be potentially disastrous and contextualised user expertise provided some defence against these dangers. The age of the site and its somewhat ad hoc construction made these dangers all the more real.

> I think the perception is that at a certain level of detail process plants like this are a bit like weather systems. There is a degree of unpredictability built into them and to retain responsibility for that continuous operation you probably need to put some human being in charge of it. Somebody who, if you like, can put up the umbrella when it's actually raining rather than when the weather forecast says it should be [22].

Staff in the production programming department still had "a lot of faith in paper systems" since they were "often simpler and quicker to use" [13]. Largely informal, personal contacts, with operators, lab staff and Head Office personnel were seen to be the route through which novel problems and queries would be solved and answered.

> When you just want a small piece of information it's quicker to telephone the lab rather than exit the system you're using, enter RIS, get the information, exit RIS, and go back into your original system [23]

> Most of the information to do the job comes from personal contact with the blenders.. I frequently check with the blenders to try and trace the cause of problems I've noticed on the system, such as why a particular product has been downgraded [14].

Given this characterisation of production programming it is easy to see how the e-mail system whose introduction was contemporaneous with RIS's was seen to be the most important change in computer support for production programming activities. Users seemed to be keener on exploiting the opportunities provided by computer mediated communication than on the use of computer produced information.

> The e-mail system has provided some really big benefits. That's definitely the change that's helped the most [13].

> I use e-mail all the time [24].

Moreover, the refinery's attempts to gain BS5750 Quality Assurance accreditation [25] meant that e-mail gained some precedence over previously widely used telephone contacts. BS5750 accreditation necessitated some formalisation of these previously "informal" contacts.

> If we note problems with a unit's performance we 'phone the unit supervisor to find out what's wrong with it and then inform the blenders.. When BS5750 comes in we'll have to contact them via e-mail as well so that the contact is documented [26].

Other changes in working practices predicated upon the introduction of enhanced computerised support were seen to be less welcome. Previously developed successful applications of simple computer tools were partially displaced by RIS and concerns were raised about the consequences of such actions. One of the refinery's Oil Accountants who was a regular user of the COMA (Computerised Oil Management Accounting) system was particularly peeved by changes made to this tool in order to facilitate its integration with RIS. His concerns were not restricted to the RIS system. RIS was merely the latest of a long line of disturbances to his working that provided him with few tangible benefits.

> The COMA system is perfectly OK for my needs. The only problem is that every time a new system is introduced COMA has to be changed even if it's running perfectly well. They never change the new system to suit the old [6].

For users in the production programming department RIS was seen by some to be too much of a move towards automation. Existing practices interacted here with notions of the importance of contextualised expertise and knowledge. Prior to the introduction of RIS, production plans and schedules had been constructed by production programming staff on Lotus spreadsheets, using information from the Sciconic LP models. As we noted in the previous chapter, there was a relatively high level of expertise in the use of spreadsheets at Grangemouth refinery [27]. Rather than being seen as a tedious re-keying of information and a waste of time, processing of information and plans using spreadsheets was seen to have distinct advantages. Not least of which was a human "check" on the reasonableness of the plans produced.

> The spreadsheet is very good at identifying where differences have occurred. All differences require explanation - if the spreadsheet can't explain it we have to investigate further [28].

LP plans derived from the system needed "tidying up" [23] and they were tidied up using a Lotus spreadsheet.

> We use spreadsheets to make up the blending requirements. We take the original qualities in the tanks, what we want to end up with, and then mess about with the components on the spreadsheet until we get what's required. That's then printed out and goes down as instructions to the blenders [23].

Analysis and checking of plans and reports using Lotus was seen to be particularly important for "vetting" purposes [13]. Use of spreadsheets made information and plans "checkable" [13] and this was seen to be "the most important function of spreadsheet analysis" [13]. Attempts to increase the automation in the production of plans and schedules were seen to be inappropriate by production programmers as it required "contextual knowledge not held on the information systems" [23]. Indeed, complaints were made about RIS's inability to accommodate and reconcile free style commentaries providing explanations of deviations from the routine operation of plans and pieces of plant with RIS information on the "technical" status of those plans and pieces of plant. Again we see users wanting a computer based storage and communication system rather than a "technical" information system.

It is worth noting however, before concluding consideration of the users' views on RIS, that some of them had very different demands. Staff at BPOUK's Head Office wanted <u>certain</u> plans about future refinery production produced and distributed by the RIS system. Their positioning in the refinery production network meant that this was the sort of information they required. They wanted to treat the refinery as something of a modularised "black box". Given inputs, they wanted to know outputs and vice versa. Only with such certain and deterministic information could they provide the traders with opportunities to generate value.

Grangemouth produces their production plans with MIMI for the next week to two weeks, at the most. And we [want the system designers to] somehow get an interface that takes the production rates out of MIMI into RIS and extrapolates forward, quantity and quality. I mean we're working to this plan and we believe this plan is right and it's the correct model. It's the best data we have on the future. We shouldn't be allowing people to say, "No, I don't think it's quite like that, if I were you I'd allow for this". In this day and age we shouldn't be doing that. Those things should already be accounted for and embodied in the model. If it isn't, if somebody does now and again say, "Look!", which they're going to do, then the model should be improved [15].

The Head Office users relative distance from the practicalities of refining on an imperfect site are made clear. Traders needed to believe in the certainty of the information they were provided with internally in order to be able to manage and make money out of the external uncertainty with which they were confronted. Refinery production programming staff were no more able to provide a definitive plan with the system than traders were able to provide a definitive figure for the oil price in two weeks time. Users recognised the importance of <u>their</u> expertise to do <u>their job</u> but the tasks of others were seen to be relatively programmatic and routinised. We also see in the above quote the re-raising of the initial objective that was seen to lie behind the introduction of the first RIS system at Rotterdam.

Thus we see continued contingency in the development of RIS, right up to and including the production of specific user applications. RIS had to enrol the site and its users and it had to become embedded in current practices. As a result the users, the system, the site and its techniques and practices mutually shaped each other through the logics of re(-)presentation. In the discussion chapter that follows we consider RIS's relations and effects in terms of the two theoretical chapters that preceded our empirical material. This section enables us to examine in more detail the links between the RIS development and the emerging "New Commercial Agenda" [29] discussed in the introductory chapters. In the epilogue to this thesis we then examine how RIS had to enrol with explicit introductions of this new agenda, the "BS5750 Part 2 Accreditation" and "Project 1990" which sought to inculcate a new, dynamic culture throughout the BP Group.

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3. Interview: Production Programmer 1 (Grangemouth Refinery) 2nd Interview 20th June 1991.

4. Interview: Production Programmer 2 (Grangemouth Refinery) 1st Interview 11th April 1991.

5. Interview: Offsites Operator (Grangemouth Refinery) 1st Interview 16th May 1991.

6. Interview: Oil Accountant (Grangemouth Refinery) 1st Interview 15th April 1991.

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10. Interview: Member of Reliability and Loss Control Group 1st Interview (Grangemouth Refinery) 13th May 1991.

11. Interview: Commercial Manager (Grangemouth Refinery) 1st Interview 5th June 1991.

12. Interview: Production Programmer 3 (Grangemouth Refinery) 1st Interview 16th January 1991.

13. Interview: Production Programmer 1 (Grangemouth Refinery) 1st Interview 15th November 1990.

14. Interview: Production Programmer 4 (Grangemouth Refinery) 1st Interview 5th February 1991.

15. Interview: Refinery Programming Manager (BPOUK, H.O., Hemel Hempstead) 1st Interview 7th June 1991.

16. System Builders Interviews with Prospective and Actual Users June 1991.

17. Interview: Senior Process Engineer (Grangemouth Refinery)
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18. Interview: Senior Laboratory Technician (Grangemouth Refinery)
1st Interview 15th November 1990.

19. Interview: Systems Manager 4 (Grangemouth Refinery) 1st Interview
10th May 1991.

20. Interview: Systems Manager 5 (Grangemouth Refinery) 1st Interview
28th May 1991.

21. Interview: Systems Manager 3 (Grangemouth Refinery) 1st Interview
18th April 1991.

22. Interview: Systems Manager 1 (Grangemouth Refinery) 2nd Interview
7th November 1991.

23. Interview: Production Programmer 5 (Grangemouth Refinery)
1st Interview 21st February 1991.

24. Interview: Production Programmer 6 (Grangemouth Refinery)
1st Interview 15th January 1991.

25. BP Oil UK's attempts to achieve BS5750 accreditation are considered in more detail in the epilogue.

26. Interview: Production Programmer 7 (Grangemouth Refinery)
1st Interview 14th February 1991.

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CHAPTER TEN

DISCUSSION AND CONCLUSIONS

Introduction

The second and third chapters of this thesis sought to fulfil a number of objectives. Firstly, they were intended to sensitise the reader to the concerns of the research and the approach adopted to meet those concerns. Secondly, they sought to open up space in which the empirical material could be presented. The confusion that may be seen to characterise the development and instantiation of RIS is made more acceptable and understandable by the prior presentation of this theoretical grounding. The theoretical chapters also considered the dangers of the approach adopted, providing further justification for the mode of empirics employed, a mode which sought to ameliorate these dangers. We were concerned not to impose a pre-established grid of analyses upon the accounts provided by organisational participants. Rather, we sought to let them tell the story, in their own terms.

In this discussion section we seek to translate the terms of organisational participants into the terms of associology, discourse and re(-)presentation, in order to offer some judgements on the processes involved in the emergence of RIS and their outcomes.

Labelling the Enunciator

Chapter four considers the emergence of the concept and first concrete instantiations of RIS within the BP Group. We saw how prior production relations and their representations were disrupted through their own "gigantic" extension and application. Rationalities of hierarchical and lateral integration, associated with an older commercial agenda, led to a refinery building programme that sought to meet an expected continued increase in demand for refined products. However, recalcitrant political reality in the Middle East disrupted and betrayed these predictions. And this recalcitrance and the "problems" it engendered may be seen to be at least partially associated with the prior activities of Western Governments and Oil Companies in the region.

Rationalities, such as the "marginal economics" of refinery operations, were applied to partially "solve" the problem through the creation of intermediary markets for refined products. Within BP a corporate restructuring introduced/reinforced new representations of activities, and the links between them, that sought to accommodate these emergent markets. Slicing the organisation up in new ways "revealed" the poor performance of refining and marketing in the newly created BP Oil and entities that had been seen to be necessary extensions of the organisation's network became rendered as "surplus capacity". Having revealed a number of its refineries as surplus, the organisation sought to remove the excess. For those refineries that remained this further increased the complexity of operations, establishing dynamic relationships with sellers, buyers and exchange partners, both within and outside the group. We can glimpse here the emergence of a new "Moral Order of Representation" (Woolgar, 1991), throwing into relief new conceptions of the boundaries of the BP organisation and the entities that constitute it (Hines, 1988). The emerging new agenda of the wider commercial world may be seen to be deeply implicated in these changes, as both a condition and consequence of this representational transformation.

Managerial complexities were particularly pronounced at Rotterdam refinery and exacerbated by a newly problematical geographical separation between supply co-ordination and production. Within the group these emergent complexities were counterfactually (Scarry, 1985) re-presented. Rather than being seen as a sign of (partially self induced) uncertainty, previously a "bad" (Beck, 1992a; 1992b), the unpredictability of the new production relations was rendered as the dynamism of the "new commercial scene" which presented significant "market opportunities". The Supply Information System (SIS) [1] was the first pass solution to the "teething" problems associated with trading in the new conditions that would allow the exploitation of these "opportunities". The system made information on refinery stocks available to "decision-makers" remote from the refinery, facilitating direct remote control. As such, the system may be seen to be something of a hangover from the era of total integration and centralised control. In the emergent circumstances, increasing the informational resources available to remote decision makers served merely to accelerate the deterioration of co-ordinated supply. It did however, reveal the "need" for a more radical intervention in refinery management. At Rotterdam management of operations was seen to be reaching "crisis point".

Rotterdam's "problems" were to be solved by the intervention of a corporate "SWAT" team, the Manufacturing and Supply Business Development Unit (BDU). Problematization [2] of oil management at Rotterdam was rendered in a manner that established the BDU as an obligatory passage point. We may label the BDU the "enunciator" or "prince" of RIS (Latour, 1988; 1991). The "cult of information" (Roszak, 1986) and the "congenitally failing" (Miller and O'Leary, 1993) nature of managerial practices, conspired to ensure that problems caused by the prior diffusion of IT would be (dis)solved through the application of a more sophisticated IT based solution. In 1985 they started to enunciate a statement, and that statement was RIS at Rotterdam. The first systems intervention at Rotterdam had successfully mobilized representations of the refinery but refinery management had been poorly enrolled in the system. The system betrayed the refinery and its managers and therefore the starting point for a new systems solution had to be the refinery itself. The BDU recommended the creation of an integrated oil management system that sought to fulfil part of the perceived need for a new form of wide, coherent, corporate production plan. The organisational magic wand of systems (Willmott, personal communication) had to meet the contradictions at the heart of the new commercial agenda head on: centrifugal pressures for devolution coupled with centripetal pressures to retain control over newly autonomised services (Power, forthcoming). Hence the emergence of a network of refinery based information systems, ideally with a common core.

Interessement and Enrolment Surrounding Rotterdam RIS

Interessement during the early stages of the first RIS implementation seems to have been relatively straightforward, although it must be said that the researcher has little direct evidence of how this occurred. Time and distance may have together enabled the black-boxing of the processes involved. The BDU was seen to represent the "strategic" objectives of the corporate centre of BP. It mobilized notions of competitiveness, technological dynamism and increased potential for profitable trading. And, perhaps most importantly, it was offering managers at Rotterdam a "tool" to help them to manage their refinery, potentially giving them access to all the rather sexy notions associated with the system. The creation of intermediate markets, the programme of refinery shutdowns and the emergence of immediate electronic trading, had already served to break many of the links of the refinery's prior network of relations, an essential pre-requisite of a successful interessement. And the BDU's proposed solution offered to re-integrate the expertise of refinery managers, nearer to the operational coal-face.

The BDU re-presented the interests of the group, the refinery, and refinery managers, as being served by the emergent RIS system. Key entities were (successfully) enrolled and RIS at Rotterdam was realised. The brevity of consideration of the emergence of Rotterdam RIS is not intended to suggest that its production was in some sense less contingent or more easily achieved than subsequent instantiations - the system cost over $20 million to produce. Rather, more detail is available on the Bulwer and Grangemouth implementations, and thus it is upon those versions of the system, particularly the latter, that we focus.

The application of calculative rituals to the first RIS development demonstrated the commercial advantage provided by the system, and despite the "somewhat suspect" motivations behind this first implementation, a number of key corporate entities became convinced that RIS, both as an idea and as a <u>realised</u> system, offered an advantage that was not organisationally specific. RIS, as a charcoal grey, if not an entirely black-box, was decontextualised from the relations of its production and made mobile. The concept of RIS was seen to be entirely mobile, as was approximately 50% of its systemic physical instantiation at Rotterdam.

<u>Mobilizing RIS at Rotterdam: Stabilising OMS at Bulwer Island</u>

The "context" of RIS's second instantiation was seen to be very different from that where the original "text" was produced (see Latour, 1991). A great deal of work had to be done on both the text and context (and their re-presentations) in order to enable the creation of the Bulwer Island OMS. The new commercial agenda's desire for the maintenance of a translated form of central control over autonomised units, coupled with rationalities offering economies of scale, had already conspired to hold out the dream of a centrally supportable common system core. But the difference of the Bulwer situation and the spirit of technological confidence and dynamism pervading the group at the time of the Bulwer implementation were such that numerous changes to the Rotterdam core were sanctioned. A new key sub-system application was accepted with significant implications for the shape the overall system's core database. These changes seem to have been accepted since Bulwer's OMS was seen to be the Mark II of RIS, the start of the next generation of refinery information systems, an improved tool that having been translated would now be more transportable.

The entities representing refining activities in the business and data models employed at Bulwer Island were the same as those used at Rotterdam. However, the relationships between them were modelled quite differently. The two systems presented a facade of similarity that was incapable of fulfilling the common core role to which it was assigned. Still, systems following the Bulwer lead would have a common core, or so it seemed. However, the deviations from Rotterdam's core, embodied in the Bulwer OMS did not produce a satisfactory system, although this was not immediately apparent. The intricacies of the links between representational elements, particularly recursive links, betrayed the objectives prescribed for the system. Its "representations" degenerated into "simulations" (Baudrillard, 1983). The system created and compounded a series of "normal accidents" (Perrow, 1984) forcing some severe technological backtracking. Changes (unsuccessfully) made to Bulwer system also revealed the programme of RIS implementations to be a succession, rather than a progression. Stability at one application site was not necessarily transportable and the speed of subsequent developments at other sites prevented problematic outcomes being apparent before their causes were adopted elsewhere. The rate of RIS's diffusion may be seen to institutionalise failures.

Interessement at Grangemouth

In Chapter five we started to examine the emergence of the Grangemouth RIS. The site already had a number of computerised systems in place but their development had not been informed by the desire for centralised integration that lay behind the deployment of RIS. In 1987 Rotterdam was still the exemplary system within the BP Group, the starting point for future implementations. Grangemouth was not as affected by the development of intermediary markets as Rotterdam had been. The refinery had also been the victim of previous system oversells. As a result there was seen to be no demand from the site for a RIS type system until a corporate will made the introduction of such a system virtually inevitable. Again the Manufacturing and Supply BDU may be seen as the enunciator of a statement, the statement being the 1987 Strategy Study. The different representations of context at Grangemouth and Rotterdam necessitated a different problematization at Grangemouth. A system to facilitate optimisation of refinery operations at Grangemouth was not required because of an obvious "crisis". Rather, the spread of commercialism within the group's refining sector was seen to make improvements to the value added performance of the refinery and its wider network desirable. Most of the opportunities for such improvements were seen to be "oil based" and these aims were translated into the objective of producing an overall reliable refinery plan "in four hours".

Interessement at Grangemouth was harder work in the absence of a commonly accepted pressing need, and the weight of the wider group's strategic objectives was required to ensure co-operation at the refinery. The BDU were keen to translate existing systems into an overall integrated system that would allow staff at the refinery to "maximise the value added to feedstocks". Again dual justifications for such an approach seem apparent. Firstly there is the obvious economic benefit of not having to "re-invent the wheel" and secondly, the BDU, by adopting such a strategy may be seen to be cognizant of the refineries current position, facilitating the enrolment of Grangemouth employees and the extant materiality of the site. The BDU was keen to present itself as representative of the interests of Grangemouth management. Opportunities for novel enquiries of a central database of oil based information were represented as resources for refinery managers, even though there was seen to be little need for such facilities on site.

The importance of links with the refinery network as a whole are also apparent here. The Process Instrumentation Project, already underway, was enrolled in the study as was the Oil Stock Control Accounting System (OSCA) being developed by BP Oil International. The translations necessitated by RIS's representations, were to alter maps of the refinery, modes of mapping the refinery, and the refinery itself. These issues became more apparent later in the development, particularly with regard to the Feasibility Study's calls for a "Flow Meter Uncertainty Reduction System" and improvements to the machinery used for blending and introducing additives in the tank farm area.

The BDU also sought to enlist the commitment of refinery personnel by acknowledging their situated expertise. Refinery personnel were to be provided with a tool to help them do their jobs, not an extension of automation to remove their jobs (even when that was what some organisational participants wanted). And they were to vet the spread of representations in the system to prevent it becoming "self-fulfilling", providing further evidence that they would be in control of the system, rather than the other way round. The dangers of a self-fulfilling system may be seen to represent an explicit acknowledgement of the simulational (Baudrillard, 1983; Cooper, 1993) potential of the system to be developed.

A more detailed study was suggested that would be better able to <u>enrol</u> refinery personnel, whilst the benefits of proceeding, demonstrated in the Strategy Study by some rather dubious rituals of calculation, served to ensure that this occurred. The resulting Feasibility Study was considered in detail in Chapter six.

<u>Enrolling Grangemouth</u>

The Grangemouth RIS so-called Feasibility Study may be seen as a series of documents that exemplifies the translation process, most particularly the phase of enrolment. RIS at Rotterdam betrayed the BDU through its inability to deal with a subsequent joint venture and betrayal by Bulwer's OMS became apparent soon after. Sites that had been successfully enrolled by these emergent systems had been unable to sustain the mobilization of entities, particularly refinery users. Systems had been seemingly successfully built but their usefulness had been strictly limited as the specifics of the networks in which they were enrolled unravelled. As a result, the system design team had to do a great deal of work to ensure that RIS at Grangemouth stayed on the rails. Firm management was seen to be the key to success, reminding us that the new commercial agenda does not constitute an abandonment of managerialism, merely a progressive transformation.

The importance of firm management was partially derived from the then exemplary system built at Rotterdam (the joint venture which betrayed Rotterdam's RIS was not mentioned in the Feasibility Study). Rotterdam's RIS was the first BP IS project to "come in on time and on budget and do what it was meant to do". Moreover, strong project management was deemed to be necessary to ensure that the commonality of the core database at the heart of each RIS system was maintained. There was however a curious importance attached to "faith" in the system. Despite the numerous calculative regimes employed in a number of justificatory trials, "faith" and not only so-called fact was seen to play a key role in the maintenance of organisational support for the system. Without those involved in the project having faith in the system, and more importantly, exhibiting it, the powers that be would not be convinced and the project would have difficulty proceeding (see also, Dugdale and Jones, 1993).

The Feasibility Study built upon the recommendations of the Strategy Study, although the level of similarity between the two reports' suggested development paths was diluted as the Feasibility Study progressed. By the time of the production of the Final Report, a number of significant changes had been suggested and accepted.

Representing Similarities Between Grangemouth and Rotterdam

Large numbers of Grangemouth staff (40 in the "Business Requirements" Stage) were enrolled in the project in an attempt to achieve a successful translation. Their involvement served to further inculcate the inevitability of RIS within the refinery and to dissipate the feeling of imposition associated at the site with externally ceded systems projects. The system design team noted the narrowness of view of current refinery staff and sought to transform them for, and with, the emergent RIS system. A particularly important vehicle for enrolment was seen to be the adoption of a Joint Application Development (JAD) approach to system implementation. However, much of the system had already been (temporarily) stabilised by the time users were involved: Rotterdam's RIS was to be the departure point (and indeed arrival point!) for most sub-systems and particularly for the central database. Invocation of JAD, much like invocation of HRM in other settings (see Keenoy and Anthony, 1992) must be seen in terms of its rhetorical power to produce truth, not in terms of the prior truth of its depictions of organisational reality.

In order to ensure that apparently "cost free" (and of course common) Rotterdam software was the starting point for RIS at Grangemouth the system design team invested a great deal of effort in representing the two refineries as similar. Moreover, they even rescheduled activities to ensure the availability of Rotterdam staff to work on the project. Such a move also provided grounds for early implementation of aspects of the system, serving to further ensure that (a Rotterdam based) RIS development would go ahead at Grangemouth.

One major departure from the Rotterdam approach was sanctioned by the team. This was the adoption of the MIMI Production Programming system that had been employed at Bulwer Island. MIMI had potential for expert systems development and the keen technological innovators of the system design team were eager to import such potential into the relatively Luddite Grangemouth refinery. MIMI had been adopted by other refineries and hence it was "essential" that Grangemouth adopted it too, in order to prevent the perpetuation of a "site specific solution" at the refinery. Interestingly, the non-economic costs of such a decision were seen to be in terms of the control of the system's potential flexibility. Again we see the implications of the contradiction between flexibility and control (usually re-presented as "coherence") at the heart of the new commercial agenda. RIS systems had to make refinery operations both flexible and predictable. Head Office users were also enrolled, demonstrating the challenges to extant organisational boundaries that emerging RIS systems may be seen to (re)produce.

MIMI at Grangemouth was to have as much commonality with MIMI at Bulwer as possible, but the rest of the system had to exhibit its commonality with Rotterdam. These two embodied precedential guides to design may be seen to be symptomatic of the entire RIS deployment story. Adopting tried and tested solutions from elsewhere was an important part of the justificatory and legitimatory networking surrounding the RIS development.

Re-Presenting Rotterdam: New Rules of Commonality

In early 1990, despite the intentions embodied in the five volume Feasibility Study, Grangemouth adopted the Bulwer Island database as the core for development of RIS at the site. As we noted, Bulwer's OMS, having destroyed Rotterdam's (potentially common) core, held out the promise of future commonality and coherence and hence economies of scale. OMS was seen to be "data driven" and "more of a toolkit to assist managers". Commonality was no longer to be achieved by representing refineries as similar, rather it was to be derived from a simple framework able to accommodate data driven site specific detail. The (successful) development of Rotterdam RIS which had previously been represented as a result of "firm management", was now seen to be a fortunate outcome of a combination of ad hoc techniques. Although Bulwer Island had patently not employed "sound project management" principles, they had adopted "sound design practices", particularly the use of a simple framework within a data driven system. Performance problems at Bulwer were already apparent, but either glossed or represented as soluble if lessons were learnt. The main casualty of these changes seems to have been the potential for free, unmediated, flexible inquiries of the central database. Problems were to be solved through "the careful tuning of inquiries", presumably by systems' professionals.

The Bulwer system was finally established as an obligatory passage point through its incorporation in the "Overall Design Report" for Grangemouth RIS produced in May 1990. This document established a design framework for Grangemouth RIS that was intended to facilitate the modularisation of subsystem development. The adoption of the Bulwer starting point may be seen to exemplify the mood of technological dynamism and optimism that was still growing the group's refining sector at the time. This approach was, not surprisingly, particularly pronounced in the minds of the system professionals from BP and Scicon who were to build the system.

Mobilizing the System, Staff and the Refinery Network

The general approach adopted by the system designers was intended to "deliver a commercial advantage" to the refinery through integrated and improved representations of various refinery and wider group activities. The lack of a call for such information prior to RIS's implementation being re-presented as a need for such information.

As Bulwer's performance problems became more apparent less technological solutions to refinery management problems became the order of the day. The system at Grangemouth was explicitly designed to provide "an overview of performance" not to facilitate "technical control". The aim was to provide common, widely available and more commercially oriented information on the refinery's activities in order to further instantiate the emergent new commercial agenda in the artefacts of the organisation. Artefacts may be seen to be more durable (Latour, 1991) than mere rhetoric, rules and conventions. They exhibit an irreversibility (Callon, 1991) and an invisibility (once built) that enables them to function more effectively than understandings embodied only in the body. Despite the creative and integrative mechanisms of the self, the body remains "a volume in perpetual disintegration" (Foucault, 1977).

The form taken by RIS at Grangemouth was a compromise between the tried and tested solutions favoured by indigenous staff and the "blue skies" solutions favoured by the system builders. Although given the mood of technological backtracking that was sweeping through refining following the system "failures" at Bulwer and Rotterdam, the balance tended to favour the former. Technology may be seen to be important to the new commercial agenda, particularly in its early stages, but situated expertise enabling exploitation of that technology to further the interests of the employing organisation is seen to be even more important, and increasingly so.

Systems staff at Bulwer were now re-presented as "overstretching" themselves and "trying to go too far with the technology available".

Earlier suggestions of expert system functionality at Grangemouth were soon forgotten, in favour of "simple algorithms" [3].

Re-Enrolling Site Specifics

Initial support for Grangemouth's existing systems had been diluted during the Feasibility Study, with suggestions for the adoption of systems from outside. These had been adopted through their embodiment in the Bulwer core. However, as the system was being built the importance of the specifics of the Grangemouth site and its prior production relations became more important. Grangemouth was seen to be an old plant with "built in unpredictability". The complexity of the refinery network, coupled with the age of the plant was seen to result in inherent uncertainty that systems interventions could not wish away. Some attempts were made to accommodate this view, although technological solutions, such as automation of valves, were represented as uneconomic. Rather, space had to be created to ensure that human expertise drove the site. One quote sums up this orientation particularly clearly:

> I think the perception is that at a certain level of detail process plants like this are a bit like weather systems. There is a degree of unpredictability built into them and to retain responsibility for that continuous operation you probably need to put some human being in charge of it. Somebody who, if you like, can put the umbrella up when it's actually raining rather than when the weather forecast says it should be. (Interview, Systems Manager 1, Grangemouth Refinery)

Organisational participants were not however, to be given a system that required no accommodation on their part. Instead there was a perceived need to "adjust human resources to technical capabilities". The system, the site and the system's prospective users may be seen to be mutually shaping through the vehicle of (selective) re-presentations of each others' attributes and interests.

These compromises were perhaps most apparent in the system builders' deliberations and negotiations surrounding the database reporting system. Various options reflected various representations of the capabilities and desires of staff and managers at the site, as well as representations of the "technological" capabilities of the emergent system. In the end "limited user imagination", "lack of need for such reports" and "the dangers of open access" together resulted in the majority of users being provided with entirely pre-defined reports, with some "more advanced" users being given limited flexibility of access to aspects of the database. Such access was mediated by the Computer Services Committee, at least in the first instance. Users could manipulate sections of predefined reports using spreadsheets, again reflecting the increasing importance of site specific realities and routines as delivery of the final system progressed.

Ensuring Continued Mobilization

A great deal of effort was also devoted to ensuring that the completed system would be used. Benefits Management procedures were employed to ensure the maintenance of user mobilization. Previous implementations had revealed how users at the site could betray the system once implemented by not using it, and thus not delivering the potential commercial benefits the system was intended to produce. Some of these practices may be seen to be overtly coercive, reflecting the key importance of demonstrable improvement in commercial performance as a result of RIS implementation.

> The system must, in the final analysis, be used.. I have no doubt that the RIS system will do all the things it should, although I do still have some doubts particularly with regard to whether or not the potential benefits are realised in practice, and more particularly, that they are seen to be realised. (Interview with Senior Manager, Grangemouth Refinery)

Planning and improving planning were seen to be the route to commercial success. Improvements in planning and the commercial exploitation of these improvements had to be demonstrated. The markets in which traders were dealing were future oriented, and thus the construction and colonisation of reliable, functional representations of future performance was seen to be essential.

Enlightened planning practices, embodying appropriately integrated representations of activities and markets, were required to square the circle of autonomous flexibility with coherence, predictability and control. Numerous translations were required to achieve these objectives, as we noted. Instantiation of the new commercial agenda, particularly in the representations and artefacts of the organisation, is revealed as incredibly complex and contingent, and indeed, often contradictory. And there was still no guarantee that refinery personnel would submit entirely to the transformed roles ascribed to (prescribed for) them.

Resistance Through Re-Enrolment in Prior Networks

Despite the numerous attempts to enrol and mobilize users in the furtherance of the new commercial agenda through their relations with the emergent RIS, refinery personnel were able to subvert aspects of the project with many of their prior working practices. Previously sanctioned representations of organisational reality were utilised to undermine many of the re-presentations embodied in RIS. Such processes also served to bolster the esteem granted to the situated expertise of refinery personnel.

RIS had increased the visibility of representations that had always been regarded as slightly dubious, but had been easily circumvented pre-RIS. Moreover, RIS's recursive use of information created a huge potential for the the magnification of small errors allowing the spectre of the Bulwer failure to haunt the Grangemouth system. The lack of respect for the system and its information that such concerns engendered facilitated modes of working that by passed the system. RIS data and information was represented as remote from refining "reality", as it was defined by Grangemouth staff, and human involvement was deemed to be essential for the prevention of reification of the system's representations. Some staff resented changes, that had to be made around the RIS development to facilitate its "bedding down", particularly if they did not expect to be users of RIS in the future.

Staff's faith in paper systems was retained since they were "often simpler and quicker to use" and the telephone continued to provide them with access to human expertise. Indeed, the element of computerisation deemed to be most useful on site was the introduction of e-mail facilities. As we noted in the previous chapter, users seemed keener on computer mediated communication than on computer generated information.

Despite the "tool to support activities" orientation of the system builders, many users felt that RIS still represented too much of a move towards automation. Aspects of the system's functioning allowed some circumvention of human involvement when expertise was seen to have been embodied in the system. For many this involvement had played an important "checking" role and its removal, particularly when coupled with the dubiousness of certain of RIS's representations, was a dangerous and foolhardy step. "Contextual knowledge not held on the information system" was required to run a refinery safely and productively.

However, the beauty of the new commercial agenda lies in its ability to (re)direct resistance towards its own ends. The ends of the agenda represent near universal "goods" (Power, personal communication) and particularly in the context of a recessional economic climate, space for resistance is almost entirely delimited to questioning of means. With the emergence of the "politics of the product" (Miller and O'Leary, 1993) the only accounts that count are those that explicitly seek to contribute to organisational well-being. There is obviously space here for the re-presentation of organisational interests to serve self interests (see for example, Munro and Kernan, 1993). However, the self (re)creating effects of the agenda serve to partially ameliorate these "dangers" for the organisation.

Professionals and managers increasingly have to present themselves as able to bring about improvements in the organisation's performance, in the future. A meritocracy based upon predicted performance is as much of a chimera as one based upon past achievements. Still, the act of re-presenting oneself in such a manner acts, in the long run, to change the self in the direction of representational convenience. "The world becomes more like our representations and less like the world" (Cooper, 1993, p. 10). The self is a thing of this world and there are no a priori grounds for making it a special case. The self is by no means immune to re-presentational transformation.

Conclusions

The development of the three RIS type systems at Rotterdam, Bulwer Island and Grangemouth, considered in this thesis, allows us to examine the intertwinings of discourse and notions of representation in the emergence of managerial technologies [4]. We saw how the "need" for RIS was created at Rotterdam and the self sustaining rationale for the diffusion of IT at work. The "problems" of refining, however created, were to be solved with a systems solution. Rotterdam's RIS was a somewhat surprising success leading system builders in the organisation to try to "overstretch" themselves to improve upon it at the second RIS instantiation at Bulwer Island.

The role of technology in the new commercial agenda is both problem and solution. The agenda demands the development and adoption of the latest technology, but only when marshalled to meet more "fundamental" organisational objectives, embodied in users and ideally designers. The latter can attempt to build in these objectives to the technology as it emerges just as the technology builds its objectives into designers and users. But as the Bulwer experience showed within the BP Group, the "technology" can go too far. In attempting to represent the complexities of refining in recursive models greater complexity may indeed be re-presented.

The fits and starts surrounding the Grangemouth implementation reflect the emergence of this understanding within the Group. RIS at Grangemouth was to be Rotterdam like, Bulwer like, and eventually Grangemouth like. Only then could it enrol the site specific expertise essential to its success. Where the system itself prevented the achievement of commercial advantage, new and old modes of working were employed to circumvent it. Discourse, prior practices and prior technology together enabled users to discount the technology when it could be deemed to be inappropriate. For, in the new commercial agenda the institutionalised understandings that constitute managerialism and embody and inform managerial objectives are not silenced, they are simply more effectively employed and more deeply embedded in the bodies of employees and the artefacts of organisation.

NOTES AND REFERENCES

1. Known as RIS1 within BP Oil.

2. As we noted in Chapter two, the four phases of translation do not necessarily occur in a tidy sequence. In our account of RIS, phases occur in a variety of orders, differing in relative importance throughout the creation and dispersal of the system. Depending upon the perspective adopted, i.e. the designation of the enunciator at various stages in the process, a number of phases may be seen to be repeated.

3. There may be few fundamental differences between "Expert Systems" and "Simple Algorithms". Those that do exist would seem to be of degree rather than nature, although differences are admirably reinforced and supported by the marketing efforts of software houses.

4. And vice versa.

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EPILOGUE

Introduction

During the latter stages of the research undertaken at Grangemouth, two key organisational initiatives began to impact upon the refinery. BP Oil UK was in the process of seeking BS5750 Quality Assurance Part 2 Accreditation and the BP Group as whole had embarked upon a structural and cultural change programme, known as "Project 1990". Together these two initiatives may be seen to constitute an explicit attempt to introduce the new commercial agenda to the organisation. From our perspective they may be seen to represent a corporate rubber stamping of changes already underway. These initiatives may have contaminated the material gathered by the researcher, but the prevalence of aspects of the new agenda in the accounts provided by organisational participants before these changes had had significant impact at the refinery and the ease with which those participants produced such accounts suggests that this was not the case. The initiatives will undoubtedly have helped legitimate the new agenda as it emerged within the group, providing organisational participants with a range of new justificatory resources. But Project 1990 in particular may be seen to represent a recognition and ratification of change processes already underway rather than a source of radicalisation itself, despite suggestions to the contrary made by some of its key proponents.

BS5750 Quality Assurance Part 2 Accreditation

BS5750 Part 2 is a Quality Assurance Programme produced by the British Standards Institute that seeks to assure quality through a proceduralisation of production and management processes [1].

> Getting the procedures written down in a format that meets BSI and then ensuring that people work to these procedures. It's as simple as that [2].

Benefits to the refinery of accreditation were seen to be "managing to get things right first time" through the imposition of a "uniform.. and standardised" way of doing things [2]. The cost to the refinery of achieving accreditation was estimated to be between £0.3 and £0.5 million [3]. If procedures became too tight, organisational participants could invoke Project 1990 to loosen them up.

Project 1990

Project 1990 was seen to arise from "a sense of unease in the management of BP that we were not as efficient as we should be in making decisions and using people" [4]. It sought to increase the flexibility of various elements of the organisation as well as that of the organisation as a whole. The project was seen to be the baby of the Group's new Chairman and Chief Executive Officer, Robert Horton, who had experienced the "can do attitude" [4] in America and sought to engineer it within the whole of the BP Group. Project 1990 was actually an organisational restructuring initiative but was immediately followed by a culture change programme, the two initiatives being seen as synonymous by many of the Group's employees.

It's quite helpful as a model to look at the whole thing as a three cornered stool... You can alter the organisation, you can tinker with the processes and change those to support the new organisation, but the third leg is really crucial, and that, for want of a better work, we call culture. Because unless you can motivate, interest, equip people to work in ways that support rather than contradict the new organisation and the new processes, the whole damn thing won't work [4].

Changes were introduced by taking all employees through workshops where they examined what the "new desired behaviours" were and developed a...

game plan for themselves about what they need to do, and what they need to start thinking about their people doing and then thirdly, utilise all those tools to come up with better working practices [4].

The project was seen to be "big bikkies". It was split into three phases and costs for phase 2 for BP Oil alone were estimated to be "about five million quid" [4,5].

And that just includes you know, consultants' fees, fares, hotels, you know, all that, the hardware if you like. It does not include the enormous amount of costing of people's time. I mean if you included that you could probably quadruple the figure [4].

Re-presenting RIS

In the face of these two large scale programmes, seen to be supported from "the very top" RIS was re-presented <u>within</u> the organisation as part and parcel an overall shift in orientation. Three major strategic initiatives were subsumed into one grand strategy. RIS had to be seen as part of the solution, not part of the problem, if it were to stand any chance of bedding down and maintaining the mobilization of enrolled entities. It would have been foolhardy, even suicidal, for the system to engage in a trial of strength with such forces. Alliance rather than confrontation was the order of the day.

One of the system builders at Grangemouth noted that RIS "would've worked an awful lot better if that culture had been in place when we started" [6]. Whilst another noted that RIS and Project 1990..

> were watered from the same change. The change is to make BP's refineries more commercially effective and to put a commercial focus on their operations. RIS is one facet of that development and the organisation[al changes are] another facet of that development [7].

And although the BS5750 initiative was seen to be "largely customer driven" [8] an effective RIS system was seen to be a central part of the accreditation process and of the maintenance of accreditation. It was also to be significantly affected by the drive for accreditation.

> All of that [the system's side] has to be highly specified as well, and the big difficulty was ensuring that interfaces, you know, reflect in one department what happens in another.. So that was a bit of a nightmare [2].

RIS, even when nearing completion at Grangemouth, had to ensure that it was represented as part of the explicit introduction of the new commercial agenda. As the thesis has shown, this was not too difficult since RIS was deeply implicated in the implicit introduction of the new agenda that preceded its corporate ratification. These final points serve to demonstrate that translation is a process that is never complete, only more or less temporarily stabilised. Entities enrolled may betray their networks at any time and seek enrolment with competing networks.

Final Word

It seems appropriate that the last words of this thesis should be those of one of the organisational participants at the refinery. The researcher was having a drink and a pleasant chat with one of the refinery's senior managers at a local bar. They were discussing Project 1990 in particular but also more general changes underway in the refinery. The manager told an epochal story that exemplifies the themes of this thesis and demonstrates their (re)creative purchase on the individuals who encountered and (re)produced them.

> I was at a fair at the weekend and entered an event in which the competitors had to get a trained dog to retrieve a number of hidden items in the shortest possible time. Most of the other competitors attempted to closely direct the dog as it searched for the objects. I just pointed it in the right direction and encouraged it, you know, let the dog use its own intelligence and training on the ground, to do the task itself. And I won! [9].

NOTES AND REFERENCES

1. Less charitable descriptions, provided to the researcher by senior managers in other accreditied organisations, represent BS5750 as a system that enables managers to proceduralise mistakes.

2. Interview: Quality Co-ordinator, Grangemouth Refinery
1st Interview 15th July 1991.

3. Interview: Quality Manager, Grangemouth Refinery
2nd Interview 10th July 1991.

4. Interview: Senior Manager at BPOI Corporate Centre, London.
1st Interview 23rd July 1991.

5. And phase 3 was the biggest phase!

6. Interview: Systems Manager 2, Grangemouth Refinery,
3rd Interview 7th November 1991.

7. Interview: Systems Manager 1, Grangemouth Refinery
1st Interview 14th October 1991.

8. Interview: Refinery Training Manager, Grangemouth Refinery
2nd Interview 9th July 1991.

9. Unfortunately the text here is reconstructed from notes made immediately after the conversation.